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'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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Honours Hygiene.

BY

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LAWS GOVERNING THE FLOW OF FLUIDS IN PIPES.

In the case of a vessel full of water, and having a tap attached in the side of the vessel close to its bottom, the velocity with which water issues from the tap is the same as that acquired by a body falling freely by gravity from a height equal to the height of the water in the vessel.

Thus if v = velocity in feet per second, and h = the height or head of water in the vessel reckoned in feet, then $v^2 = 2gh$,

and $v = 8\sqrt{h}$.

From this can be obtained the formula—

$G = \sqrt{h} \times d^2 \times 16{\cdot}3$, in which

h = head of water in feet,

d = diameter of orifice in inches,

G = number of gallons discharged per minute.

These formulæ only give the *theoretical* velocity and discharge, and require modification according to the particular form of the orifice.

(1.) If there is a discharging orifice in a thin plate, as from a tank, the stream just inside of its point of issue becomes contracted, owing to the converging currents of water; the greatest contraction being at a point whose distance from the plate is equal to half the diameter of the orifice, and whose diameter is related to that of the orifice as ·784 : 1.

It is evident that the velocity at the aperture will be less than at the point within this at which the stream is contracted, in the ratio of the areas of the two points, *i.e.*, as 1^2 to $·784^2$ or 1 : ·615.

Thus in this case $v = \sqrt{h} \times 8 \times ·615$,

and $G = \sqrt{h} \times d^2 \times 16{\cdot}3 \times ·615$,

$= \sqrt{h} \times d^2 \times 10$.

For further particulars see Box's *Practical Hydraulics* (Spon), from which several of the following examples are taken.

Example.—An orifice 3 inches in diameter leads from a vessel 16 feet high, which is full of water; what is the discharge per minute?

$G = \sqrt{h} \times d^2 \times 10$

$= \sqrt{16} \times 3^2 \times 10 =$ 360 gallons per minute.

Example.—If there is a discharge of 150 gallons per minute from an orifice 2 inches in diameter, what is the head?

$$G = \sqrt{h} \times d^2 \times 10$$

$$\sqrt{h} = \frac{G}{d^2 \times 10}$$

$$h = \left(\frac{G}{d^2 \times 10}\right)^2 = \frac{22500}{1600} = 14{\cdot}06 \text{ feet.}$$

Example.—If an orifice discharges 200 gallons per minute with 20 feet head, what is its diameter?

$$G = \sqrt{h} \times d^2 \times 10$$

$$d^2 = \frac{G}{\sqrt{h} \times 10} = \frac{200}{44{\cdot}7}$$

$$d = \sqrt{\frac{200}{44{\cdot}7}} = 2{\cdot}11 \text{ inches.}$$

(2.) Where the aperture is thick, or has the form of a short tube not less in length than twice its diameter, the contraction of the stream is less and the discharge greater than with a thin plate.

If the diameter in this case is 1 inch the greatest contraction is to ·9 inch, and its proportional area $·9^2 = ·81$ of the area of the tube.

The formula in this case is—

$G = \sqrt{h} \times d^2 \times 16{\cdot}3 \times ·81$

$= \sqrt{h} \times d^2 \times 13$.

(3.) Where a long pipe forms the means of discharge, it is necessary to allow not only for the loss of velocity at the point of entry, but also for the loss due to the friction of the water against the sides of the pipe.

BRITISH MUSEUM

The loss of head by friction may be calculated by the following formula:—

$$G = \sqrt{\frac{(3d)^5 \times h}{L}}$$

where d = diameter of the pipe in inches,
L = length in yards,
h = head of water in feet,
G = gallons discharged per minute.

This formula frequently requires the use of logarithms, and a saving of labour is ensured by their use in every case.

Example.—Find the discharge of a 7-inch pipe 3,797 yards long with 45 feet head.

$$G = \sqrt{\frac{(3d)^5 \times h}{L}}$$

$$G^2 = \frac{(21)^5 \times 45}{3797} = 48375$$

$\therefore G =$ 220 gallons per minute.

Example.—Find the head necessary to discharge 320 gallons per minute by an 8-inch pipe 3,457 yards long.

$$G^2 = \frac{(3d)^5 \times h}{L}$$

$$102400 = \frac{7962624 \times h}{3457}$$

$h =$ 44·46 feet head.

Example.—Find the diameter of a pipe sufficient to discharge 110 gallons per minute with 56 feet head, the length of the pipe being 273 yards.

This example will be worked out by logarithms to show the saving of labour secured by this method.

$$G^2 = (110)^2 = \frac{(3d)^5 \times 56}{273}$$

$$\frac{(110)^2 \times 273}{56} = (3d)^5$$

$\therefore 2 \log 110 + \log 273 - \log 56 = 5 \log 3d.$
$\log 110 = 2{\cdot}0413927$
$\log 273 = 2{\cdot}4361626$
$\log 56 = 1{\cdot}7481880$
$\therefore \log 4{\cdot}770761 = 5 \log 3d$
$\therefore \log 3d = \log {\cdot}954152$
$\therefore 3d = 8{\cdot}9981$
and $d = 2{\cdot}99$, or practically 3 inches diameter.

Example.—What will be the relative discharge of a 3-in. and a 5-in. pipe, both being of equal length, and the same difference of head being maintained between the ends? (Edin. Univ. B.Sc. in Pub. Health, 1875.)

Assuming that the length of the discharge pipe in each of these cases is not less than twice its diameter, the following formula will determine the relative discharge:—

$$G^2 = \frac{(3d)^5 \times h}{L}$$

In this example L and h remain constant in the two cases; but in the first case $d = 3$ and in the second $= 5$ in.

Then the discharge will vary as follows:—

$$G^2 = \frac{(9)^5 \times h}{L} \qquad G^2 = \frac{(15)^5 \times h}{L}$$

and the relative discharges per minute will be in the proportion

$$\sqrt{\frac{(9)^5 \times h}{L}} : \sqrt{\frac{(15)^5 \times h}{L}}$$

Example.—Calculate the diameter of a pipe necessary to convey water to a town of 2,000 inhabitants from a reservoir 5 miles distant, with a head of water of 50 feet. (Cambridge Univ. D. P. H. Exam., 1887.)

The daily amount of water required per head is usually stated as 35 gallons, or 70,000 gallons for 2,000 inhabitants.

If the discharge of water were uniform throughout the twenty-four hours, then $G = 48{\cdot}6$ = number of gallons requiring to be discharged per minute.

As a matter of fact the water is required chiefly during the day, and it would be safer to assume that G is double the above amount, or 97·2 gallons.

$$G^2 = \frac{(3d)^5 \times h}{L}$$

$L = 5$ miles $= 8{,}800$ yards
$h = 50$ feet $\quad G = 97{\cdot}2$

$$(97{\cdot}2)^2 = \frac{(3d)^5 \times 50}{8800}$$

$(97{\cdot}2)^2 \times 176 = (3d)^5$
$5 \log 3d = 2 \log 97{\cdot}2 + \log 176$
$= 3{\cdot}9753326 + 2{\cdot}2455127$
$= 6{\cdot}2208453$
$\log 3d = 1{\cdot}2441690$
$3d = 17{\cdot}545$
$d =$ 5·848 inches.

Example.—The head of water in a main is 100 feet above the main. What time will be required to fill a cistern of the capacity of 20 cubic feet, 70 feet above the main, through a 1 in. pipe 120 feet long—neglecting resistance of the bends.

(Edinburgh Univ. B.Sc. in Pub. Health, 1875.)

Here $h = 100 - 70 = 30$
$d = 1 \qquad L = \frac{120}{3} = 40$
20 c. ft. $= 20 \times 6{\cdot}24 = 124{\cdot}8$ gallons

$$G^2 = \frac{3^5 \times 30}{40} = \frac{729}{4}$$

$G = \frac{27}{2}$ = number of gallons discharged per minute.

Total capacity of cistern = 124·8 gallons
Therefore time required to fill the cistern =

$$\frac{124{\cdot}8 \times 2}{27} = 9{\cdot}24 \text{ hours.}$$

Example.—Find the discharge per minute of 6 in., 9-in., 12-in. pipes, each 3,000 yards long, with 40 feet of head.

(*a*) $G^2 = \frac{(18)^5 \times 40}{3000}$

$\therefore G = 159$

(*b*) $G^2 = \frac{(27)^5 \times 40}{3000}$

$\therefore G = 438$

(*c*) $G^2 = \frac{(36)^5 \times 40}{3000}$

$\therefore G = 898.$

It is evident that the size of the pipe has a very important influence on the amount of water discharged.

The rule is that when L and h are constant the discharge is directly as the 2·5th power of the diameter. Thus in the above example

$$159 : 898 :: (6)^{2\cdot5} : (12)^{2\cdot5}.$$

The preceding remarks do not exhaust this question, but will suffice to solve ordinary problems. In practice allowance has to be made for loss of head by bends in the pipes, in addition to allowance for friction. The following general rules are useful:—

(*a*) The head is proportional to the square of the discharge by any pipe, or series of pipes; and conversely

(*b*) The discharge by any pipe or series of pipes is proportional to the square root of the head, when the diameter and length of the pipes remain constant. These rules are true for pipes with contractions, bends, &c.

(*c*) When the head of water and length of pipe are constant, the discharge per minute is directly as the 2·5th power of the diameter of the pipe; and conversely

(*d*) The diameter will vary as the 2·5th root of the discharge.

(*e*) When the discharge and length of pipe are constant, the head is inversely as the 5th power of the diameter; and conversely

(*f*) The diameter is inversely as the 5th root of the head.

(*g*) When the head of water and diameter of pipe are constant, the discharge is inversely as the square root of the length; and conversely

(*h*) The length varies inversely as the square of the discharge.

(*i*) When the discharge and the diameter of the pipe are constant, the head is directly and simply as the length.

Example.—(*a*) State whether water will flow faster or slower through a large pipe than through a small pipe if both pipes are full. (*b*) Answer the same question if the pipes are not full but convey a constant quantity of water; distinguishing between different cases, if any distinction is necessary.

(Edin. Univ. B.Sc. in Pub. Health, 1883.)

By the preceding rule (*c*), the discharge per minute is directly as the 2·5th power of the diameter of the pipes.

If h, d and L were given, then the relative discharge could be found by the formula

$$G^2 = \frac{(3d)^5 \times h}{L}$$

When the pipes are not full, the discharge is best calculated by first obtaining the velocity of flow by Eytelwein's formula, $v = 55\sqrt{h} \cdot f$, where v = velocity in feet per minute, h = hydraulic mean depth in feet, f = fall (in feet) in 2 miles. The amount of fluid discharged per minute = sectional area × velocity. (For further particulars see last month's PRACTICAL TEACHER.)

Example.—Two cisterns are connected by a pipe. What several quantities determine the rate of passage from one to the other? If a second pipe be introduced between them, how does it affect the discharge according as it is (*a*) alongside of, (*b*) end to end with, the first?

(Edin. Univ. B.Sc. in Pub. Health, 1883.)

The rate of discharge is determined by the various elements in the formula

$$G^2 = \frac{(3d)^5 \times h}{L}$$

If a second pipe be introduced running parallel with the first, and of the same diameter, and having the same head, the discharge will be simply doubled.

If the second pipe be used to lengthen the first, the increased length will produce greater friction and thus diminish the discharge, as may be shown by working out any instance by the preceding formula.

Example.—What will be the flow of water through a 3-in. pipe 1,000 feet long, running full, with a loss of head between the two ends equal to 5 feet?

(Edin. Univ. B.Sc. in Pub. Health, 1880.)

$$G^2 = \frac{(3d)^5 \times h}{L}$$

$$= \frac{9^5 \times 5}{\frac{1000}{3}} = 885{\cdot}73$$

$\therefore$ G = 29·7 gallons per minute.

Example.—By what formula would you compute the quantity of water passing through various sized pipes from various distances and from various 'heads'?

(City and Guilds Technical Institute Exam., 1886.)

(*To be continued.*)

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Quarterly Arithmetical Tests.

BY JOSEPH WOLLMAN,

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STANDARD I.—FIRST QUARTER.

1. 6	2. 589	4. Find the sum of 39 slates, 56 slates, 78 slates, 43 slates, and 27 slates.
408	346	
31		
5	3. 725	
264	120	

SECOND QUARTER.

1. 59	2. 468	4. A boy had 89 nuts, and he bought four dozen and a half. How many had he then?
780	386	
17		
592	3. 630	
3	424	

THIRD QUARTER.

1. 967	2. 804	4. A shopkeeper had three hundred tops. He sold 65, 149, and 37. How many had he left?
304	795	
95		
8	3. 953	
679	87	

STANDARD II.—FIRST QUARTER.

1. 3,456 + 16,729 + 805 + 57,490 + 18 + 90,537.

2. 78,609 × 47.

3. What is the difference between twenty-eight thousand and nine and forty-thousand and six?

4. Alfred had 594 marbles. He lost 246, then won 367, and he gave 158 away. How many had he at last?

SECOND QUARTER.

1. How much greater is ten thousand and twenty than seven hundred and sixty-five?

2. Multiply 97,531 by 860.

3. Divide twenty-four thousand two hundred and thirty-seven by three, and write the answer in words.

4. How many wheels have 79 hansoms and 68 cabs?

THIRD QUARTER.

1. 58,310 ÷ 9.

2. Find the difference between 486 dozen and 397 score.

3. What is the product of 4,059 and 67,038?

4. If five yards of cloth will make a suit of clothes, how many suits could be made out of 17 pieces each 35 yards long?

STANDARD III.—FIRST QUARTER.

1. Divide four hundred thousand and six by eighty-six.

2. A man plants cabbages in 19 rows, and 23 in a row. If 37 of them are stolen, how many will be left?

3. Find the quotient of five million fifty-one thousand six hundred and twenty-five and seven hundred and nine.

4. A train travels 38 miles an hour and goes 9 hours a day. How many days will it take to go 4,446 miles?

SECOND QUARTER.

1. Add £263 15s. 8¼d., £47 16s. 5½d., £11 18s. 7¾d., £5 12s. 9½d., £825 11s. 6¾d., £751 14s. 11¼d., and £6 13s. 10¾d.

2. Twelve thousand one hundred and fifty nuts were divided amongst a number of boys. One boy got only 28, while the others got 38. How many boys were there?

3. How much less is £780 16s. 9¾d. than £1,070 13s. 10¼d.?

4. A boy saves 2d. a day; how much will he save in a year?

THIRD QUARTER.

1. Take £418 15s. 4¼d. from £40,027 10s. 3d.

2. £305 18s. 7¾d. + £58 13s. 10½d. + four thousand pounds and eleven pence + 283 farthings.

3. What number multiplied by 567 will give two million seven hundred and three thousand four hundred and fifty-six?

4. A woman went shopping with a sovereign and a half. She spent 12s. 8d. at one shop, half that amount at a second shop, and half the second amount at a third shop. How much had she left?

STANDARD IV.—FIRST QUARTER.

1. Divide two hundred pounds by 365.

2. £1,987 15s. 10¾d. × 87.

3. How much is the four hundred and thirty eighth part of one million three hundred and thirty-four thousand and seventy-three pounds twelve shillings and seven pence halfpenny?

4. Multiply a guinea and a half by five thousand and sixty-nine.

SECOND QUARTER.

1. Add together 359 pounds, 359 shillings, 359 pence, and 359 farthings.

2. Reduce 78 miles 5 fur. 5 yards to inches.

3. How many bicycles at £14 each are worth 49 tricycles at £18 each?

4. Seven boxes of oranges weighed 1¼ tons. The boxes alone weighed 15 lbs. each. How many lbs. did the fruit weigh?

THIRD QUARTER.

1. A lady wanted to buy 47 yards of calico at 11½d. per yard, and found that she had 1s. 3½d. too little. How much had she?

2. How many qrs., &c., are there in five hundred thousand and eighteen half-pints?

3. Multiply one million and seventy pounds eighteen shillings and eleven pence farthing by 526.

4. How many trees, each occupying 1 ro. 15 po., can be planted in a park containing 104½ acres?

STANDARD V.—FIRST QUARTER.

1. What is the difference between the cost of 789 tables at £3 18s. 6d. each, and 987 chairs at 17s. 11d. each?

2. Find the value of 38 stones 11 lbs. 10 ozs. at 11s. 8d. per stone.

3. What would be the cost of 3,517 fowls at 4s. 11d. a couple?

4. If coals are bought at half-a-guinea a ton and sold at 9½d. per cwt., what would be the gain on 38 tons 12½ cwt.?

SECOND QUARTER.

1. If a shopkeeper paid 12s. 6d. in the pound, and still owed £600, what was the total amount of his debts?

2. If the tax on a house rated at £26 is 18s. 5d., what is the tax on one rated at £38?

3. What would be the cost of 398 sq. yds. 5 ft. 135 in. of land at 10 guineas per square yard?

4. Make a bill for the following:—

3 chests of tea, each 106 lbs., at 1s. 9d. per lb.;
5 „ „ 127 lbs., at 1s. 11d. „
98 cwt. 21 lbs. of rice at 16s. 4d. per cwt.;
76 bags of coffee, each 1 cwt. 1 qr., at 1s. 4½d. per lb.;
¾ ton of sugar at 1½d. per lb.

THIRD QUARTER.

1. Simplify $(\frac{7}{8} - \frac{5}{12}) - (\frac{3}{10} - \frac{1}{6})$.

2. $\frac{8}{9} - \frac{7}{11} + \frac{6}{7} - \frac{7}{12} + \frac{9}{10} =$.

3. A man buys 74 yards of cloth at 2s. 7½d. per yard. If he gains £6 6s. 5d., what is the selling price of 3½ yards?

4. After paying away $\frac{3}{8}$ of my money and 5s. 9d., I had 11s. 9d. left; how much had I at first?

STANDARD VI.—FIRST QUARTER.

1. Multiply 19 thousandths by 28 ten-thousandths, and divide the product by $\frac{3}{4}$ of ·0532.

2. Divide the least of $\frac{4}{21}$, $\frac{5}{27}$, $\frac{6}{81}$, and $\frac{7}{36}$ by the greatest.

3. Simplify

$$\frac{\cdot 7\dot{5} - \cdot 3\dot{6}}{\cdot 01\dot{2} + \cdot 1\dot{4}\dot{8}}.$$

4. How much is $5\frac{3}{4} \div 3\frac{1}{2}$ greater than $3\frac{1}{2} \div 5\frac{3}{4}$?

SECOND QUARTER.

1. If £64 16s. is ·675 of a sum of money, what is the sum?

2. Find the value of ($\frac{3}{14}$ of $\frac{8}{9}$ of 2 guineas) + ($\frac{7}{8}$ of 6·75s.) — ($\frac{8}{13}$ of 3·25d.).

3. If a man travels 644 miles in 7 days of 8 hours each, how far will he travel in 6 days of 9 hours each?

4. Reduce 3 sq. po. 13¾ yds. to the decimal of 2½ acres.

THIRD QUARTER.

1. If 20 men and 30 boys reap some fields in 12 days, how long will 14 men and 24 boys take to reap the same, if 2 men do as much as 3 boys?

2. What is the interest on £357½ for 3½ years at 5½ per cent.?

3. After spending ·$\dot{5}$ of the money in my purse, and then ·$\dot{5}$ of the remainder, I had 4s. left. How much had I at first?

4. I borrowed £970 at 3½ per cent., and lent it at 4¼ per cent. What did I gain in a year and a half?

STANDARD VII.—FIRST QUARTER.

1. A man owns $\frac{5}{12}$ of an estate. If he sells $\frac{3}{7}$ of 5¼ of ·16 of his share for £980, what is the value of the whole estate?

2. If 56 men do a piece of work in 10 days of 9 hours each, how long will it take 64 men working 10½ hours a day?

3. Find the smallest number of pounds that will contain exactly sixpence, shilling, florin, half-a-crown, double-florin, crown, and half-a-guinea.

4. For £750 I got 3 ac. 3 ro. of land. What portion of land could I get for £500, if the value of the latter is to the former as 3 : 4?

SECOND QUARTER.

1. If 1½d. is paid every calendar month for the loan of a sovereign, what is the rate per cent. per annum?

2. Give the average as a recurring decimal of $4\frac{3}{4}$, $3\frac{7}{16}$, $5\frac{2}{3}$, and $6\frac{5}{8}$.

3. A's share is $\frac{4}{5}$ of B's, and B's is $\frac{7}{16}$ of C's, which is £19 more than $\frac{1}{2}$ of A's. What is A's share?

4. The average of 12 cricket matches was 156. The average of three was 98, and of two 174. What was the average of the remainder?

THIRD QUARTER.

1. If the value in the rent of a house rose from £6 5s. to 17½ guineas, what was the increase per cent.?

2. In what time will £237 10s. gain £54 0s. 7½d. at 3¼ per cent. per annum?

3. A sum of money at 4¾ per cent. is £3 15s. less than at 5⅜ per cent. What is the sum?

4. A person invests a certain sum in the Three-and-a-Half per Cents. at 98½, and sells out at 103¼. If he gains £216, what sum did he invest, brokerage being ⅛ per cent. on each transaction?

ANSWERS.

STANDARD I.

	FIRST.	SECOND.	THIRD.
1.	714.	1,451.	2,053.
2.	243.	82.	9.
3.	605.	206.	866.
4.	243 slates.	143 nuts.	49 tops.

STANDARD II.

	FIRST.	SECOND.	THIRD.
1.	169,035.	9,255.	6,473 + 8.
2.	3,694,623.	83,876,650.	2,103.
3.	11,997.	8,079.	272,107,242.
4.	557 marbles.	430 wheels.	119 suits.

STANDARD III.

	FIRST.	SECOND.	THIRD.
1.	4,651 + 20.	£1,913 3s. 11⅓d.	£39,608 14s. 10¾d.
2.	400 cabbages.	320 boys.	£4,364 19s. 4d.
3.	7,125.	£289 17s. 0½d.	4,763.
4.	13 days.	£3 0s. 10d.	7s. 10d.

STANDARD IV.

	FIRST.	SECOND.
1.	10s. 11½d. + 10 q.	£378 16s. 4⅞d.
2.	£172,938 2s. 11½d.	4,981,860 inches.
3.	£3,045 16s. 7½d.	63 bicycles.
4.	£7,983 13s. 6d.	2,695 lbs.

	THIRD.		
1.	£2 3s. 9d.	3.	£526,037,318 1s. 1½d.
2.	488 qrs. 2 bus. 1 pk. 1 gal. 1 pt.	4.	304 trees.

STANDARD V.—FIRST.

1. £3,096 16s. 6d. − £884 3s. 9d. = £2,212 12s. 9d.
2. £22 13s. 0¼d.
3. £432 5s. 11½d.
4. £10 6s.

SECOND.

1. £1,600.
2. £1 6s. 11d.
3. £4,185 18s. 6½d.
4. £27 16s. 6d. + £60 17s. 1d. + £80 3s. 8¾d. + £731 10s. + £10 10s. = £910 17s. 3¾d.

THIRD.

1. $\frac{1}{15}$.
2. $1\frac{8888}{15873}$.
3. 15s. 2d.
4. £1 8s.

STANDARD VI.

FIRST	SECOND.	THIRD.
1. ·001¾.	£96.	16 days.
2. $\frac{11}{19}$.	7s. 5½d.	£68 16s. 4½d.
3. $2\frac{11}{14}\frac{1}{4}$.	621½.	£1 0s. 3d.
4. $1\frac{11}{12}$.	·00863.	£10 18s. 3d.

STANDARD VII.

FIRST.	SECOND.	THIRD.
1. £9,408.	7½ per cent.	194 per cent.
2. 7½ days.	5·1197916.	7 years.
3. £21.	£7.	£600.
4. 2 acres.	178¼.	£4,734.

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Practical Needlework in Elementary Schools.

BY MISS J. W. WARREN,

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MY intention this month is to deal with the teaching of specimens only, and first I will call my reader's attention to the alterations that have now practically become law. The teaching of marking is deferred to the Fifth Standard; no other work being substituted teachers may congratulate themselves upon a diminution in this otherwise difficult Standard. Our preparations are therefore limited to gathering, flannel patch, darning thin place on *stocking web*, button and hole. Notice, too, the seeming incongruity of the Schedule III. and 'Instructions.' The patch in former to be three inch, in latter two inch; but this no doubt is to enable the work to be more finished upon the examination day. All who aim at good work should begin to teach the gathering and buttonhole quite early in the school year; dexterity is gained only by repeated attempts in these two specimens, and on no account should the garments be finished until these have been perfected in specimens. When beginning to describe the garment work I advised the teaching of specimens first, and after the garments were finished a re-practising of them in the two last months of the school year. I need only add that the same rule holds good for the four upper standards.

'To gather and stroke down seven inches and fix into a band of three inches.'

This operation is made up of five distinct parts, namely:—

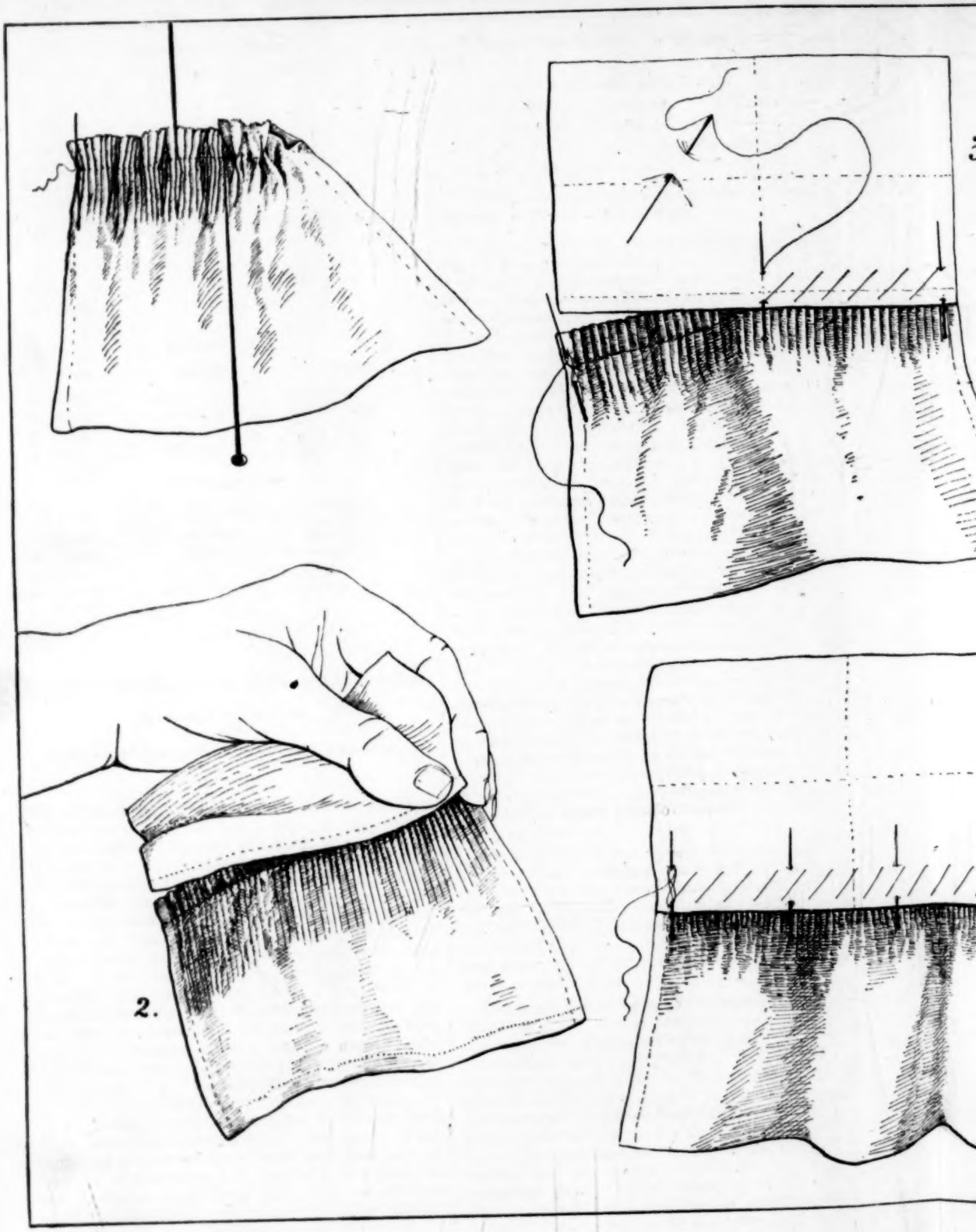
1. *Put in a gathering thread.*
2. *To arrange the gathers.*
3. *To prepare the band.*
4. *Fix gathering piece into the band.*
5. *To work after fixing.*

I should encourage every young teacher to so consider the work and teach it in this order.

Plan.—First we will consider the uses of gathering; it is to give requisite fulness—usually at throat, waist, and leg of garments otherwise plain. It follows that we shall sometimes have to do work with the warp across the weft, and quite as often on the bias. Teach it first across from selvege to selvege. Indeed very little else can be done, since it is a difficult compound operation, requiring considerable skill. Still a few examples on the bias should be given prior to garments. Keep to the size recommended, as it is just a good one for manipulating. For first trial use unbleached calico, and prepare in the following way:—Have for each child a piece 7 × 3, the longer side running with the warp. A narrow hem should be *fixed not worked* on each short side—this hem is often omitted, but is really necessary to teach two important steps—one the right and wrong sides, the other how to overcome the extra thickness when gathering and setting in; these pieces, when thus prepared, represent the garment. Call it by some name—apron, pinafore—but do give it a name. My reason is obvious. With a large specimen in front of the class illustrate every step. A neat fold as for the first hem fold should now be made from hem to hem, but on the *right* side. Get your pupils to turn this down at this stage *by a thread*, but do not give the number of threads of the required fold—18 or 20 will make about one third of an inch, and it is far better to avoid the strain consequent upon counting by giving the Standard measure. Now this fold, when done well, gives a clear groove in which to work the gathering thread. Two other methods (not equally good) are a black lead mark and a tacking thread.

When each child has folded and is ready to begin the thread take a checked blackboard and with chalk represent the stitch, which should be on all materials the same in proportion—two threads taken up, four left down—worked always on the right side of garment, and started with two or three back stitches upon the hem which, unless more than an inch wide, should never be gathered up.

The pupils should be taught to work one stitch at a time at first, and should keep in the groove and to the proportion, though not counting the threads; the cotton should be stouter than that used for hemming the same garment, a double thinner thread is sometimes used but always appears to me a premium to carelessness. When the thread is put in the needle should be unthreaded, and a small knot may be made. It will be necessary to cut this work off, and do another and yet another before it will be done well enough to proceed to the arranging of the gathers. Do not attempt the second step on anything but the perfectly done gathering thread. We now suppose this is ready; use the needle with which the work has been done to secure the thread; you thus avoid its



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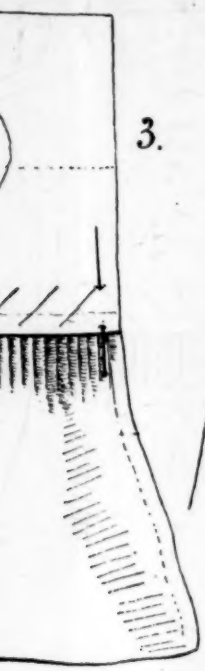

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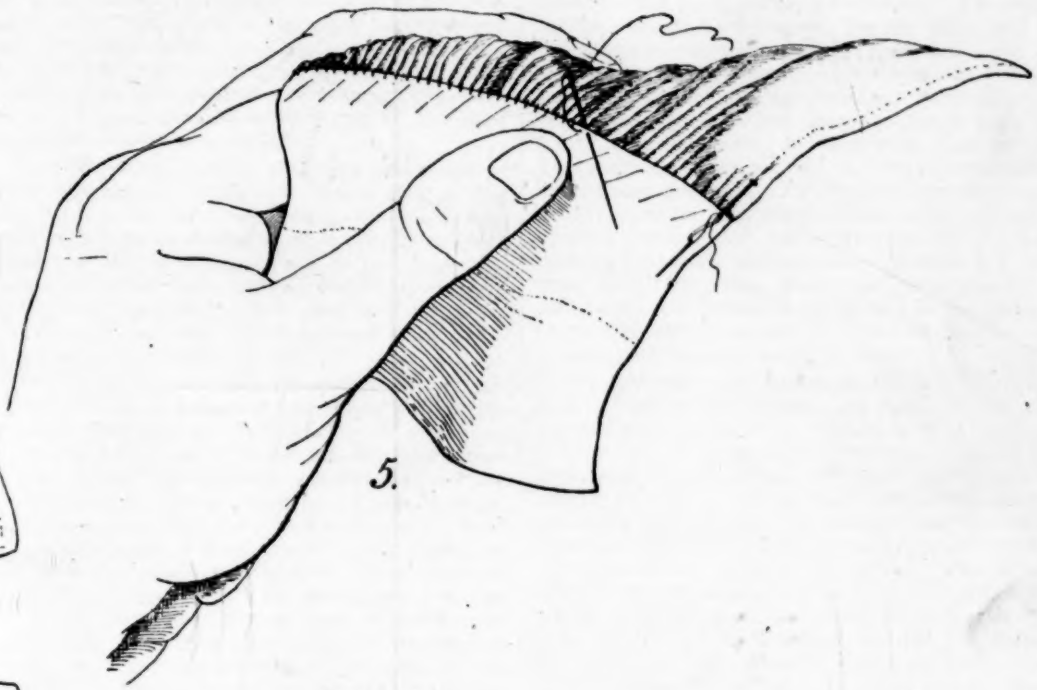

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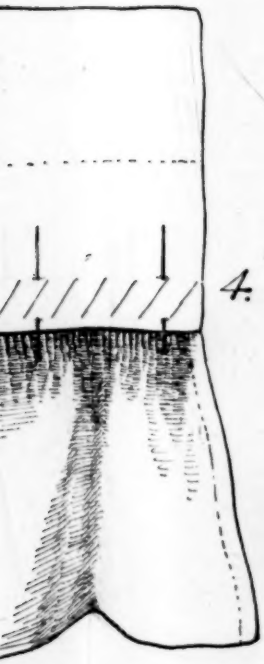

4.

1. Arranging gathers above and below the thread

2. Picking up band and gathered piece ready to fix.

3. Fixing the band on with pins and cotton.

4. Band fixed ready for work.

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5. How to hold the band and sew in the gathers.

use for the arrangement of the gathers a pin is usually too large; stick the needle, point uppermost, into the hem, just where the last stitch of thread came out, only take a small piece of material up with it. Now with cotton end in right hand, and garment in left, gently draw up the gathers nearly tight, and twist cotton round needle. It is now ready for the second step, commonly called 'stroking.' I have given a sketch of this process, and can only hope it and my words may do some good in producing good gathers, for of all plain needlework it is one of the most beautiful and most often abused.

Hold the work between the finger and thumb of left hand just at needle (to begin) with a long steel pin fine at point, but strong, find each long stitch in the groove on which rests the pin, and with it move the fold of material closer to your finger and thumb, but do not make any noise with the pin's point at all; place two or three folds thus, then *reverse the pin* and help each little fold thus placed by moving it gently *above the gathering thread.* (See sketch). Continue this until the right end is reached.

Now do it again, being very careful to put your pin where it went before. If teachers will give their pupils pins of three or four inches long they will almost entirely prevent the invariable scratch. The plan given above produces a maximum of good strokers, but on no account *omit the reverse mode*, the left hand finger and thumb, I need scarcely add, should be moved as the operation progresses. Now draw out the needle, loosen the gathers, open them wide and see if you have kept true to your directions, let your pupils hold their specimens to the window and try to detect the slightest displacement of the threads. If taught in this way they will delight in being accurate. I should now—and not before—explain the requisite proportion of gathers to the band by halving my next garment piece and placing a stitch to show the centre; this is usually done first, but as so many gathering threads are needed before one is fit for stocking, it is better left until a perfect specimen is produced, and here I feel obliged to suggest that actual garments are shown to illustrate its necessity. The ignorance existing after beautiful specimens have been produced can only be found out by experience. To neglect the utility of the subject is to be sadly deficient as a teacher of the band.

The Band.—For this size garment just completed we need a three inch square; a narrow single fold all round this is necessary, the width to be that of the fold for the gathering thread. Have this done in opposites *and the ends done first.* Explain your reason; illustrate by a large piece of paper. Show also the almost invariable direction for cutting a band selvege way; let the children see that if the ends are not folded first a double fold comes just where we begin to set it on, and gives us much difficulty, and that the strength gained at the end by our plan makes it stronger for button, tape or string case. Having folded the four sides as above, double the band as for use; crease it well, *open it up* again, and fold over edge to edge, thus getting a mark for the middle, where put a stitch. N.B.—All this can be well taught with the papers used for folding in the Kindergarten occupation.

We now come to our *fourth step.* Provide the children with a fixed band, garment, small pins, and needle and cotton. Let each place both pieces in front of her, right side uppermost, and here explain that gathers must be stocked into a space half the size. The band being picked up first at point (see sketch) with right hand, place garment edge to edge of band, hold each to each between finger and thumb. Now pin together, as indicated. Let pupils do this over and over again. Explain which end to begin, and how to place the pin; then find stitch in garment and fold in band, showing middle. Stick another small pin in same direction. Now take the two remaining edges and fasten as you began; let thread hang forward as in illustration; here lay the fixed specimen down and find that the garment is too loose under the band, carefully draw up the thread until it is just the same length as the band, and wind it round your last pin. Stick two more pins midway between the middle and end ones. Your work is now quite ready, but some people will prefer the fixing with needle and cotton, in which case let the stitches be placed exactly as shown in sketch, and on no account parallel with the line of work.

Our *fifth and easiest* step is to *set the gathers fast* by a line of careful stitches. As these require the replacement of the whole specimen it is perhaps easier to give it in a sketch. The work should be held nearly upside down, and each fold or gather picked up with a part of the band. The needle should be directed a little to the right, but the stitch shown on right side will be at right angles with the line of band and lying in the groove between two folds of material, as shown in sketch. When the pins are reached they must be withdrawn, and after the right side is 'set in,' draw out the last pin, thread the gathering end, fasten it neatly off inside, and seam up the end from fold. To gather edge continue with this cotton to do wrong side, first preparing it by a tacking thread as explained.

(The end.)

Tests in Mental Arithmetic.

STANDARD I.

1. Add 6, 9, and 11. 26.
2. What is the half of 26? 13.
3. How many must you add to 13 to make three tens? 17.
4. How many turnips are there in four rows, if two have 6 each and two have 8 each? 28.
5. How much would they be worth at a halfpenny each? 1s. 2d.
6. How much would they be worth at a farthing each? 7d.
7. How much would they be worth at two for three halfpence? 1s. 9d.
8. What is the cost of half a-pound of tea at 1s. 9d. a lb.? 10½d.
9. What would a quarter of a pound cost? 5¼d.
10. What change would you get out of a shilling? 6¾d.

11. A gentleman gave 6d. each to three girls. How much had he left out of half-a-crown? 1s.

12. If he had given them 9d. each, how much would he have had left? 3d.

STANDARD II.

1. Take 15s. 10d. from a sovereign. 4s. 2d.

2. How many halfpennies could you get for 4s. 2d.? 100.

3. What is the fifth part of that number? 20.

4. What is the fourth part? 25.

5. What is the third of a florin? 8d.

6. After spending a half and a third of a florin, how much would be left out of a florin? 4d.

7. Divide half a gross of pencils equally among 9 boys. How many will each boy get? 8.

8. What would a boy's share be worth at 12 a penny? $\frac{3}{4}$d.

9. How many could you get for $3\frac{1}{2}$d.? 42.

10. How many threepenny pieces could I get for 60 farthings? 5.

11. How many lbs. are there in 2 stone? 28.

12. What would 2 stone of apples cost at 4 lbs. for 6d.? 3s. 6d.

STANDARD III.

1. Divide £1 15s. among 7 boys. How much will each boy get? 5s.

2. Divide 5s. among 4 boys. How much will each get? 1s. 3d.

3. Add half-a-crown, a florin, a shilling, a sixpence, and 3d. 6s. 3d.

4. Take 6s. 3d. from half-a-sovereign. 3s. 9d.

5. If a boy earn 3s. 9d. in a week, how much will he earn in 4 weeks? 15s.

6. How many pence are equal to that amount? 180.

7. How many score is that? 9.

8. How many times can 9d. be taken from a crown? 6.

9. How much would be left? 6d.

10. How many yards are there in half-a-mile? 880.

11. What would half-a-mile of ribbon cost at 6d. a yard? £22.

12. What would half-a-foot cost? 1d.

STANDARD IV.

1. Take the square of 12 from the square of 13. 25.

2. What would 25 articles cost at 1s. 6d. a dozen? 3s. $1\frac{1}{2}$d.

3. How many halfpennies could you get for that sum? 75.

4. Add $\frac{1}{3}$ of a shilling and $\frac{1}{4}$ of a florin. 7d.

5. How many half-ounce packets of tea could be got out of $7\frac{1}{2}$ lbs.? 240.

6. If the total cost is £1 10s., what is the value of each packet? $1\frac{1}{2}$d.

7. If 2 sheep cost £5, what will 3 cost? £7 10s.

8. A dozen packets of envelopes cost a florin. What would a score packets cost? 3s. 4d.

9. What part of 3s. 4d. is 4d.? $\frac{1}{10}$.

10. How many pints are there in a barrel of beer? 288.

11. What would a barrel cost at 3d. a pint? £3 12s.

12. What would it cost at 4d. a quart? £2 8s.

STANDARD V.

1. Add $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$. $\frac{7}{8}$.

2. What is 4 times $\frac{7}{8}$? $3\frac{1}{2}$.

3. What number contains $\frac{7}{8}$ eight times? 7.

4. If six books cost 13s. 6d., how many could you get for 9s.? 4.

5. If 5 men build a walk in $7\frac{1}{2}$ days, how long will it take 3 men? $12\frac{1}{2}$ days.

6. What part of 3 guineas is 6s.? $\frac{2}{21}$.

7. What part of 6s. is 1s. 3d.? $\frac{5}{24}$.

8. I divided £5 equally among some men, and each man got 1s. 8d. How many men were there? 60.

9. How long is a wall which goes round a square garden containing 144 square yards? 48 yards.

10. What decimal of half-a-crown is sixpence? ·2.

11. What decimal is it of a florin? ·25.

12. What is the interest on £750 for $2\frac{1}{2}$ years at 4 per cent.? £75.

STANDARDS VI. AND VII.

1. Multiply, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, and 360 together. 3.

2. Divide $\frac{1}{4}$ of $\frac{1}{5}$ by $\frac{1}{6}$. $\frac{3}{10}$.

3. The sum of two numbers is $4\frac{7}{20}$, and one of them is 2·65. Express the other decimally. 1·7.

4. A man owned ·8 of a farm, and sold ·6 of his share. What fraction of the farm had he left? $\frac{16}{45}$.

5. Express that as a decimal. $\cdot3\dot{5}$.

6. What is the commission on £2,500 at $\frac{1}{8}$ per cent.? £3 2s. 6d.

7. If £300 amounts to £408 in 9 years, what is the rate per cent.? 4 per cent.

8. What percentage of a stone is a pound? $7\frac{1}{7}$ per cent.

9. The price of an article increases from 4s. 6d. to 5s. What is the percentage of increase? $11\frac{1}{9}$ per cent.

10. If eggs are bought at 16 for a shilling, and sold at a penny each, what is the gain per cent.? $33\frac{1}{3}$ per cent.

11. What income is derived from investing £300 in the Three per Cents. at 90? £10.

12. What rate per cent. of interest will a person receive who invests in the Four per Cents. at 80? 5 per cent.

Our Certificate Class.

BY DR. GEORGE BEACH, M.A.

Co-author of 'Our Mother Tongue,' &c.,
Head Master of Christ Church Schools, Macclesfield.

GENERAL REMARKS.

1. September 30th is the last day for notifying to the Education Department the candidate's wish to sit for a certificate at Christmas.

2. On page 6 of Form IX. the words 'Christmas Examination' should be written after the name of any 'Acting Teacher' who desires permission to sit at Christmas.

3. We are often asked to detail the steps which are required to be taken before the candidate can attend the examination.

First the correspondent of the school should apply to the Education Department to forward the necessary forms. These should be filled up and *promptly* returned.

Next the formal permission of the Whitehall authorities arrives, and then, to be quite safe, the local magnates at the chosen centre should be communicated with, and a proper acknowledgment obtained.

4. Dawson's 'Essay-Writing and Paraphrasing' can be especially recommended as a particularly thoughtful, useful and cheap manual. It is exhaustive without being prolix.

5. In our last issue (August) the Model Answers to last year's certificate questions, several replies in the 'Query Column' and pp. 274, 275 should be carefully studied.

SPENCER ON EDUCATION.

(Pages 113 to 146.)

The pages now under review strikingly exemplify the peculiarities of Mr. Spencer's views and reasoning, and may be accounted fair samples of the whole book.

The first sixteen pages, dealing especially with the treatment of offences, are open both to grave criticism and the charge of inconsistency, but of pages 130 to 146 nothing but good can be said.

Let us proceed to particulars.

Mr. Spencer (in the first 16 pages) is tilting at the ordinary methods of punishment, and especially, we believe, at corporal punishment. He tells us that it is best for 'the parent to fulfil the comparatively passive duty of letting the natural penalties be felt' (p. 113), and illustrates the proposed method by two tales respecting 'a nephew and uncle' and 'a boy experimentally (?) burning paper.'

The first of these, to our mind, proves nothing, except that when there is one teacher to one pupil—when the force of evil example has no material upon which to operate (*i.e.*, when as regards punishment only the culprit has to be considered), that summary and severe methods may often be discarded for deliberate and milder ones.

Mr. Spencer seems to forget that *in a society* the objects of a punishment are two-fold, being not only to reclaim the offender, but to deter possible culprits.

Again, supposing that lying and not ingratitude had been the offence, how would the uncle have proceeded? According to Mr. Spencer the boy would have been ostentatiously disbelieved until he had proved his return to truthfulness. But possibly no suitable opportunity would occur for a long time. Meanwhile the boy would have been going from bad to worse. Or take the case of 'cruelty to animals.' We do not hesitate for a moment to acknowledge that this fault most frequently proceeds from thoughtlessness, but still it cannot be denied that there are *some cases of wanton cruelty.* In these latter instances we maintain, and our experience has demonstrated it, that nothing is so efficacious as a 'sound thrashing.' The pain imparted by them has been felt by them, and the dread of further pangs is a great terror to the cruel nature Garotters and wife-beaters cower before the lash and cease their malpractices.

The fact is, that we should get at the root of the offence. The offence in itself is only the indication of some state of mind. What is that state of mind?

When we know this, then we can select the punishment.

The second anecdote of the burning paper seems puerile. What child old enough to appreciate Mr. Spencer's suggested methods has not seen hundreds of pieces of paper burning?

What mother, as wise as Mr. Spencer's model one, would reason so viciously as to say (p. 117), '*It is true that I may save the child from a burn; but what then?* HE IS SURE TO BURN HIMSELF SOMETIME'?

If, as in the anecdote, the child should persistently disobey, we certainly should take the paper from him and '*give him something*' in return.

As for the mother, we should send her to learn a more logical style of reasoning—not from Mr. Spencer.

Now on p. 125 we are told to '*enforce obedience at whatever cost. Let your penalties be like the penalties inflicted by inanimate Nature—inevitable. The hot cinder burns a child the first time he seizes it; it burns him the second time; it burns him the third time; it burns him every time; and he very soon learns not to touch the hot cinder. If you are equally consistent—if the consequences which you tell your child will follow specified acts follow with like uniformity, he will soon come to respect your laws as he does those of Nature.*'

If these remarks do not emphatically and imperatively urge upon the parent the duty of administering sharp, severe, immediate, inexorable and inevitable punishment they have no meaning at all. Could the most bigoted admirer of the old-fashioned style of corporal punishment advocate it more strongly?

But this excerpt also contradicts another dogma of our author's, viz.—'*that children think that their parents are their enemies if punishment for wrong-doing be inflicted.*' Yet here we are plainly told that the children will '*respect your laws as they do those of Nature.*' Does a child hate Nature because he has burnt his finger or broken his leg? Neither will a child consider its parents hostile. Do they not feed him, clothe him, and confer upon him a hundred benefits?

As a matter of our elementary school experience, we strongly declare that we never knew a child enduringly resent a deserved punishment unless incited thereto by unwise parents or weak philanthropists.

Note also (p. 115) that a foolish mother is made to say to her offspring (1) '*It is all for your good.* (2) *I know what is proper for you better than you do yourself.* (3) *You are not old enough to understand it now, but when you grow up you will thank me for doing what I do.*'

We would rather ascribe these words to a wise parent, seeing that the great and wise 'ALL-FATHER' says, (1) 'As I love I rebuke and chasten' (Rev. III. 19); (2) 'It is not for you to know the times or the seasons that God hath put in his own power'; (3) 'What I do, thou knowest not now, but thou shalt know hereafter' (John XIII. 7). And here we would add our protest against Mr. Spencer's neglect of the power of revelation or inspiration. We are not particularly orthodox ourselves in the narrowest meaning of the term, but we cannot subscribe to the utterances of pp. 48, 49. '*To the s'owly growing acquaintance with the uniform co-existences and sequences of phenomena—to the establishment of invariable laws, we owe our emancipation from the grossest superstitions. But for science we should be still worshipping fetishes, or with hecatombs of victims be propitiating diabolical deities. And yet this science, which, in place of the most degrading conception of things, has given us some insight into the grandeurs of creation, is written against in our theologies and frowned upon from our pulpits.*'

We would respectfully ask Mr. Spencer if the gospel of Jesus of Nazareth has not somewhat tended towards our present glorious freedom, bodily, mental, moral, social and political?

ROUTINE FOR SEPTEMBER (MALES).

DAY	FIRST WEEK			SECOND WEEK			THIRD WEEK			FOURTH WEEK		
MONDAY	**Algebra.** — Revision	**History.** — Revise Dates. Hanoverian Dynasty	**School Management.** — Revision	**Algebra.** — Permutations	**History.** — Revision	**School Management.** — Notes of a Lesson on the Adjective	**Algebra.** — Combinations	**History.** — Government Questions (See Article)	**School Management.** — The constitution of man. What means of Discipline (physical, mental, moral) may be employed?	**Algebra.** — Miscellaneous	**History.** — Wars of the Roses	**School Management.** — Treatment of Ringworm, Itch, Squinting, Stammering and Breaking of Voice
TUESDAY	**Euclid.** — Deductions on Book II.	**Maps.** — Tay and Clyde	**English.** — Paraphrase Lines 117—138, Scene 1, Act IV., Richard II.	**Euclid.** — Revise Book IV.	**Map.** — West Australia	**English.** — Paraphrase 'Revenge is a kind of wild justice . . . . . in past matters.' Bacon's Essays, No. IV.	**Euclid.** — First 17 Propositions of Book VI.	**Maps.** — Punjab and Bengal	**English.** — Paraphrase Lines 1027—1046 Lancelot and Elaine	**Euclid.** — Deductions on Book I.	**Geography.** — Winds, Currents and Tides	**English.** — Paraphrase Lines 221—232, Scene 1, Act IV., Richard II.
WEDNESDAY	**Arithmetic.** — Miscellaneous (see Article)	**English.** — Write 20 lines of Composition on Lines 63, 64 of Scene 4, Act III., Richard II.	**Euclid.** — Revise Book III. from Prop. 19 to end	**Arithmetic.** — Surds	**English.** — Write 20 Lines of Composition on 'Trial by Ordeal'	**Euclid.** — Deductions on Book IV.	**Arithmetic.** — Miscellaneous (see Article)	**English.** — Richard II. to end of Scene 4, Act III.	**Euclid.** — Deductions on Book VI.	**Arithmetic.** — Problems of the nature of Equations	**Music.** The Staves, Maj. & Min. Scls. Tonic Sol-fa. 1. Characteristics of Notes. 2. Major and Minor Modes 3. Names of Chromatic Tones	**Euclid.** — Revise Book II.
THURSDAY	**School Management.** — Fallacies, pp. 112—128 Jevon's Logic Primer	**Geography.** — Our Asiatic Possessions, excluding India	**English.** — Questions on matter of Richard II. (see Article)	**School Management.** — Spencer on Education. (See Article thereon)	**Geography.** — British North America	**English.** — Lines 1—240 of Lancelot and Elaine	**School Management.** — The common errors perpetrated in ordinary Notes of Lessons	**Geography.** — Australia	**English.** — Write 20 lines of Composition upon 'The victims of Henry VIII.'	**School Management.** — Spencer on Education (See Article thereon)	**Music.** — Diatonic & Chromatic Intervals, Transposition. Tonic Sol-fa. Diatonic & Chromatic Intervals. Removes of Key, Bridge Notes	**English.** — Lines 240—463 of Lancelot and Elaine
FRIDAY	**Algebra.** — Permutations	**History.** — Government, manners, manufactures under the Tudors, pp. 159—166, Davies	**English.** — Richard II. to end of Scene 2, Act III.	**Algebra.** — Combinations	**History.** — Literature, pp. 233 to 244, Davies	**Arithmetic.** — Miscellaneous (see Article)	**Algebra.** — Logarithms	**History.** — Reign of Henry VII.	**Geography.** — Australia and New Zealand	**History.** — Reign of Henry VIII.	**Geography.** — Questions on Productions (see Article)	**English.** — Bacon's Essays, 18, 19, 21, 24, and 25
SATURDAY	**Euclid.** — Deductions on Book III.	**English.** — Bacon's Essays, 1, 2, 4, 5 and 9	**School Management.** — Revise Laws of Health as applied to School Premises	**Geography.** — Rain, Clouds, Vapour	**Euclid.** — All Definitions, Book V. in particular	**Algebra.** — Examination (See Article)	**School Management.** — 'Form IX.' and its Items. The Examination Schedules	**Euclid.** — Revise Book I.	**English.** — Bacon's Essays, 11, 14, 15, 16, and 17	**Geography.** — Questions on Distribution of Life (see Article)	**Algebra.** — Revise	**History.** — Literature, pp. 244—254, Davies	**Algebra.** — Examination (See Article)	**English.** — Lines 463—700 of Lancelot and Elaine

ROUTINE FOR SEPTEMBER (FEMALES).

DAY	FIRST WEEK			SECOND WEEK			THIRD WEEK			FOURTH WEEK		
MONDAY	Arithmetic. — Partnership	History. — Dates 1649 to 1660. Curtis' Date Book	School Management. — Revision	Arithmetic. — Stocks	History. — Abolition of Feudal System. Declaration of Breda appropriating supplies	School Management. — Notes of a Lesson on 'the Adjective'	Arithmetic — Discount	History. — Triple Alliance. Secret Treaty of Dover. Scotch Insurrections, Savoy Conference. Plots against King (1649—1685)	School Management. — Man's constitution. What means of discipline (corporeal, mental, and moral) may be employed?	Arithmetic. — Partnership	History. — (1649—1685) Hudson's Bay Company. New York. Great Fire of London. Whigs and Tories	School Management. — Treatment of Ringworm, Itch, Squinting, Stammering, and Breaking of Voice.
TUESDAY	Domestic Economy. — How can you detect and remedy impurities in water? How can you detect adulteration in the ordinary beverages?	Geography. — Map of British North America	English. — Paraphrase Lines 117—138, Scene 1, Act IV., Richard II.	Domestic Economy. — The ordinary poisons (vegetable and mineral) and their antidotes	Geography. — Map of West Indies	English. — Paraphrase Lines 23—40, Scene 2, Act V., Richard II.	Domestic Economy. — Revise 'Household Management' from Text Book.	Geography. — Map of New Zealand	English. — Analyse and Parse difficult words of lines 91—100, Scene 1, Act IV., Richard II.	Domestic Economy. — Describe the outfit of a girl aged 14 years entering service, giving cost of items	Geography — History of Colonization	English. — Paraphrase Lines 201—222, Scene 1, Act IV., Richard II.
WEDNESDAY	Arithmetic. — Areas	English. — Write 20 Lines of Composition on Lines 63 and 64, Scene 4, Act III., Richard II.	Sewing, etc. — Practise needlework diagrams	Arithmetic. — Government Questions. (See Article)	English. — Write 20 Lines of Composition on 'The Stuarts'	Sewing, etc. — Practise Setting-in Gathers and Feather-stitching	Arithmetic — Problems on L. C. M. and G. C. M.	Sewing, etc. — In how many pieces should the three required garments be cut?	Domestic Economy. — Heat as a Curative. Classify ordinary diseases. Distinguish between Contagion and Infection.	Arithmetic. — Compound Proportion.	Sewing, etc. — Practise 'Plain' Needlework	Domestic Economy. — 'High Interest is bad Security,' Explain this axiom and show why rates of Interest and Profit vary
THURSDAY	School Management. — Fallacies, pp. 112—128 Jevon's Logic Primer	Geography. — Tasmania and Revision	English. — Richard II. Etymological Notes	School Management. — Spencer on Education. (See Article thereon)	Geography. — New Zealand	English. — Analyse and Parse difficult words of lines 293—304, Scene 1, Act IV., Richard II.	School Management. — The common errors perpetrated in ordinary Notes of Lessons	Geography. — Our Island Possessions.	English. — Notes and Text of Richard II. to end of Scene 4, Act III.	School Management. — Spencer on Education. (See Article thereon)	Music. — The Staves. Major and Minor Scales. — Tonic Sol-fa. Characteristics of Notes. Major and Minor Modes. Names of Chromatic Tones	English. — Notes and text of Richard II. to end of Scene 1, Act IV.
FRIDAY	Arithmetic. — Stocks	History. — Literature, etc., Davies, pp. 139 to 145. (See Article)	Writing. — 1. Dictation. 2. Copy Book. 3. Copy previously set	Arithmetic. — Government Questions. (See Article)	History. — Second Navigation Act. Poor Law Act. Habeas Corpus Act. Clarendon Code	Sewing, etc. — Cut-out the left half of a child's muslin pinafore	Arithmetic. — Fractions.	History. — (1649—1685) Wars with Dutch. Closing of Exchequer. Great Plague	Any backward work	History. — Dates 1660 to 1674 Curtis' Date Book	Music. — Diatonic and Chromatic Intervals. Transposition. — Tonic Sol-fa. Diatonic and Chromatic Intervals. Removes of Key. Bridge Notes	Sewing, etc. — Revise
SATURDAY	Domestic Economy. — What are the requirements of the first stage Specific Subject Domestic Economy?	English. — Trench, Two-thirds of Lecture III.	School Management. — Revise Laws of Health as applied to School Premises	Geography — New Zealand	Sewing, etc. — Practise Diagonal and Plain darns	Examination. — Sewing	School Management. — The Items of Form IX. and the Examination Schedules	Domestic Economy. — What extraordinary expenses should a working man provide for and to what extent weekly?	English. — Trench Lecture III.	Geography — Our European Possessions	Sewing, etc. — Cut-out the Sleeve and Collar of a woman's night-dress, and the wristbands of a boy's shirt	History, Literature, etc. — Davies, pp. 145 to 151 (see Article)	Examination. — Sewing	English. — Richard II. Notes on the Language of the Play

PARAPHRASING.

1. (Lines 117—138, Scene 1, Act IV., Richard II.)

Before high Heaven I wish that there were in this illustrious company some one of a character so sufficiently exalted as to be able legally to adjudicate upon the state of royal Richard.

The very sublimity of such a position would teach the injustice of such a proceeding.

Not one of Richard's lieges is competent to judge the royal Richard.

Even when manifest criminals are tried they are allowed to be present.

Then how enormous it is that the representative of divine dignity, God's minister, general and viceroy, whose appointment has been ratified by rites both secular and sacred, and confirmed by the lapse of years—how monstrous it is that in his absence he should be deposed by disloyal and unworthy persons! ETC.

2. (Lines 23—40, Scene 2, Act V., Richard II.)

In any dramatic representation it is extremely noticeable how carelessly the spectators view the inferior performers, and how inattentive they are to the dialogue when the principal characters have gone behind the scenes.

With such or even greater disdain was noble and kindly Richard frowningly regarded.

There was none whose pity blessed him, no pleasant greeting saluted his return, but dirt was cast at our anointed king, ETC.

3. (Lines 201—222, Scene 1, Act IV., Richard II.)

I am not willing, but as I count for nobody you shall not have a negative reply. Richard must give place to Henry. Take careful notice of what I resign.

I yield to thee mine uneasy crown. I bestow upon thee my cumbering rule, and pluck from my mind the haughtiness of royalty.

Of mine own self I do unconsecrate myself, by mine own act I abdicate. I personally declare myself to be no longer king, and absolve all my subjects from their allegiance, ETC.

(This is for many reasons a difficult passage to paraphrase and should be carefully studied.)

4. (Bacon's Essays, No. IV., '*Revenge is a kind of wild justice ..... on past matters.*')

There is a certain undisciplined equity in retaliation, nevertheless, because we are very liable to practise it, especial pains should be taken to legislate against it.

And for this reason—The original criminal simply breaks the law, but the retaliator usurps its functions. Besides, when a man avenges himself he puts himself on a level with his injurer, but when he forgives him he rises above him, he exercises the royal prerogative of pardoning. Respecting this, Solomon emphatically remarks, 'The discretion of a man deferreth his anger, and it is his glory to pass over a transgression. The king's wrath is as the roaring of a lion, but his favour is as dew upon the grass.'

5. (Lines 1027—1046, Lancelot and Elaine.)

After a time Elaine said, 'Dear brothers, I thought last night that I was once more a young inquisitive child. All went as pleasantly as in our forest rambles or river expeditions.

'I recalled our sailings up the mighty stream as far as the headland where grows the poplar.

'Beyond this you would not go, but came back with the flood tide. Even then I grieved at this restriction, and used to desire to ascend the river until we should reach Arthur's palace. But this boon I never obtained.

'However, last night I seemed to be sailing by myself with none to prohibit my advance beyond the usual limits,' ETC.

PARSING.

1. (Lines 293—304, Act I., Scene 4, Richard II.)

That, again, shadow, ha! see, all, merely, that, there, substance, king, only, me, but, how, begone, obtain.

2. (Lines 91—100, Act I., Scene 4, Richard II.)

That, seen, many, time, banished, streaming, Saracens, toiled, retired, himself, gave, soul, whose, had fought, long.

3. (Lines 59—73, Act III., Scene 5, Richard II.)

O, conspiracy, fountain, whence, his, so, be, bawd, as, gold, when, or, giving, man's.

4. (Lines 119—137, Act V., Scene 5, Richard II.)

King, pardonne-moi, teach, pardon, pardon, ah, itself, as, that, hearing, have, sick, doth, good, abbot.

STORY OF LANCELOT AND ELAINE—(*continued*).

(Page 838.)

Whilst Lancelot slept, Elaine stole quietly away through the twilight to her city relatives, with whom she passed the night. At dawn she returned to the cave and tended Lancelot all day long, again departing at even-fall. This continued many a day except when his fever was so great as to demand a night-watcher. Then Elaine stayed, and so skilfully nursed him and so patiently endured the querrelsomeness of illness that the hermit told the knight that her fine care had saved his life. And the sick man loved her—yea, deeply and tenderly, but, alas! not with man's best love, for Guinevere's attachment restrained him. Yet he at first vowed to part from the queen; but with returning health his resolve grew weak, and oft he spake coldly to Elaine, and caused her to leave him earlier than usual, sickened by unrequited love, almost even to her death.

At last Elaine, Lancelot and Lavaine returned to Astolat, whereat the knight for some time tarried. Meanwhile Elaine strove with all innocent art to win his love, but Lancelot thought to requite her devotion by granting her some great boon.

One morn he found her in the garden and said, 'Speak your wish, I go to-day.' Passionately Elaine replied, 'Let me be your wife.' 'Nay, sweet Elaine, I can never marry.' 'Then let me be your faithful servant and companion,' urged she. 'To allow that would be a poor return for all your kindness,' answered the knight; 'such a connection would be evil interpreted by the censorious world. In time you will wed with one of your own age, and I will endow you with broad lands and fight your quarrels, seeing you are true and sweet beyond mine own belief in womanhood.' Elaine said, 'Of all this I desire nothing,' and, swooning, was borne away.

Then her father, who had overheard some little of their conversation, entreated Lancelot to blunt her passion by some discourtesy. This Lancelot would not do, save that he plucked her sleeve from off his helmet and rode away without further farewell.

So was the poor maiden left to brood in her desolate tower. She received quietly the consolations of father and brethren, but felt that her heart was broken. Accordingly she composed a mournful song, descriptive of hopeless love and utter despondency, and wailed it forth with weird sweetness until her alarmed brethren hastened to her as she fell back exhausted.

After a time she said, 'Last night I dreamed of the times when a happy maid I was taken by you up the river as far as the cape which is crowned by a poplar. Further then you would not go, although I wished to progress unto Camelot. But methought in my sleep that I was alone on the flood and able to pass the ordinary limits. I awoke, but the longing remained. Now let me go that I may proceed to Court and find there peace in the presence of Lancelot, the knights and the queen.

This speech incited her brother to meditate upon injuring Lancelot, and moved her father to recite his shameful *liaison* with Guinevere. All was in vain, and the truth was viewed as envious calumny, whilst Elaine, holding fast to the belief in Lancelot's nobleness, bade her father cease his efforts and to send a priest to grant her absolution before her death.'

This having been done, she wrote a letter to Lancelot and begged her kin to grant her last wishes. 'Just before I die,' said she, 'lay this letter in my hand, and after my death prepare me a queenly couch and a black-draped barge on which and in which I may be carried to deliver my letter, as it were, myself to Lancelot; and let no one but our dumb old man go with me.'

When she had said this she appeared more cheerful even for ten days, but on the eleventh her father laid the letter in her hand and the maiden died.

Then was there great dole in Astolat.

HISTORY.

Males.

(1) (Davies, pp. 159 to 166.)

Pages 159, 160, 161, 165 and 166 are most important, and should be well studied. The answers to a considerable number of probable questions are therein contained. Page 162, 163 and 164 should have only their important points attended to.

(2) (Davies, pp. 233 to 244.)

Omit Fabian, Leland, Stowe, Bellenden, Spelman, Holland, Cavendish, Leslie, Hayward, Hooper, Pole and Cox.

(3) (Davies, pp. 244 to 254.)

Omit Becon, Whitgift, Cartwright, Bilson, Cheke, Elyot, Hatton, Burleigh, Wylson, Savile, Webb and Puttenham.

Females.

(1) (Davies, pp. 139 to 145.)

Omit Ashmole, Aubrey, John Spencer, Wood, Bolton, Sibbes, Mede, Burroughs, Reynolds, Rutherford, Caryl, Robert Leighton, Owen, Bates, Flavel and Charnock.

(2) (Davies, pp. 145 to 151.)

Omit South and Lord Edward Herbert, and condense pp. 148 to 151.

SELECTED GOVERNMENT QUESTIONS FOR THIRD MONDAY.

Males.

1. Give, with dates, a brief account of the reign of Henry VII., *or* describe the relations between England and Scotland under Henry VIII. (1889).

2. Sketch the condition of Ireland during the reign of Elizabeth, *or* trace by a genealogical table the descent of the Tudors from Edward III. (1889).

3. In what way was the power of the nobles affected by the Wars of the Roses and the Reformation? (1888).

4. Give a short account of any statutes passed which directly affected the well-being of the lower classes, *and* mention any occasions when an invasion of England was attempted or threatened by foreign powers from 1485 to 1603. (1888).

5. Explain the grounds upon which the following persons were put to death:—Sir Thomas More, Lady Jane Grey, Somerset, and Mary Queen of Scots. (1887).

SELECTED GOVERNMENT QUESTIONS ON GEOGRAPHY FOR THIRD SATURDAY.

Males.

1. How is the distribution of plants and animals connected with the distribution of land and water in past ages? Give facts. (1889.)

2. Give instances of the extermination and introduction by man of species of animals and plants into countries where they are not indigenous or aboriginal.

3. In what parts of the world would you find the following plants and animals:—bananas, lichens, tobacco, hemp, kangaroos, reindeer, tapirs, giraffes, chamois, and alligators? (1889.)

4. Where would you find the Fins, Magyars, Czecks, Basques, Pigmies and Slavs? (1889.)

5. Give some account of the plants and animals found in Australia. (1888.)

FOR FOURTH FRIDAY.

Males.

1. What districts in the British Isles, Hindostan and Australia are especially noted for wheat, cotton, gold, opium, pearls, copper, and wool? (*Adapted* 1889.)

2. From what British possessions (or colonies) do we obtain maize, quinine, rice, diamonds, hides, jute, ostrich feathers, teak and wool? (1888.)

3. From which of our colonies do we obtain (1) the Raw Materials we use in Textile Fabrics, (2) Precious Minerals and Stones, (3) Articles of Food? What do we send out in return? (1888.)

4. Describe a voyage to Australia from England, and mention the sort of cargo a ship might carry on its outward and homeward trip. (1884.)

5. Prepare the outline of a lesson for an advanced class upon 'The stream of British commerce through the Suez Canal.'

SELECTED GOVERNMENT QUESTIONS ON ARITHMETIC FOR SECOND FRIDAY AND THIRD WEDNESDAY.

Males.

FOR WEDNESDAY AND FRIDAY AND SECOND WEEK.

Females.

1. A warehouse consists of 5 floors; the rent of each floor is ·9 that of the floor above. Find the ratio of the rents of the highest and lowest floor, and find also the rent of the lowest floor. Rent of middle floor is £33 15s. *Answer.* £41 13s. 4d. as 10,000 : 6561.

2. Six horses and eight cows cost me £375. I sell them for £446 5s., making a profit of 25 p.c. on the horses and 10 p.c. on the cows. What was the average cost of each horse and cow? *Answers.* £37 10s. per horse; £18 15s. per cow. (1888.)

3. A can walk round a rectangular field, whose sides (in yards) are 411·6 and 548·8, in the same time that B takes to walk from one corner to the opposite corner and back. Find the ratio of their rates of walking. *Answer.* As 7 : 5. (1886.)

4. A man went to market and spent £200. He bought 200 animals, consisting of sheep, pigs, and young geese. For each sheep he gave £5, for each pig £1, and for each goose 1s. How many of each did he buy? *Answers.* 38 sheep, 2 pigs, and 160 geese. (1887.)

5. The distance from London to Dover is 75 miles, from Dover to Calais 20 miles, and from Calais to Paris 180 miles, and I pay £2 17s. 6d. for my ticket. The rate per mile being by boat $2\frac{1}{2}$ times more, and by French railway $2\frac{3}{8}$ per cent. less than by English railway, find the respective shares of the two railways. *Answers.* English, 13s. $5\frac{3}{11}$d.; French, £1 11s. $5\frac{1}{11}$d. (1889.)

6. In a race of 100 yards A allows B 4 yards' and C 6 yards' start in order that they may reach the goal at the same time. How much start should B allow C when B has to run the whole distance? *Answer.* $2\frac{1}{13}$ yards. (1889.)

7. If I sell a horse for £62 and a cow for £26, I gain 10 p.c. on the original cost of both; but if I sell the horse for £63 and the cow for its original price I lose 10 p.c. Find the original cost of each. *Answers.* Cow £9; horse £71. (1880.)

8. A person walks to a town at the rate of $3\frac{3}{4}$ miles per hour, and rides back at the rate of $7\frac{1}{2}$ miles per hour after having rested half an hour; he then finds he has been absent 4 hours 10 minutes. What was the length of the walk? *Answer.* $9\frac{3}{8}$ miles. (1866.)

9. A and B can do a piece of work in $3\frac{3}{7}$ hours, B and C in $3\frac{3}{4}$ hours, A, B and C in $2\frac{1}{2}\frac{1}{7}$ hours. If A and B work for 2 hours, how long will A and C take to finish it? *Answer.* $1\frac{1}{8}$ hours. (1880.)

SELECTED GOVERNMENT QUESTIONS IN ALGEBRA FOR SECOND AND FOURTH SATURDAYS.

1. Show that the number of combinations of n things taken r at a time is the same as the number taken $n - r$ at a time. (1888.)

2. Prove that $\log \frac{m}{n} = \log m - \log n$, and that $\log m^n = n \log m$.

In what time would any sum of money treble itself at 5 p.c. compound interest per annum? *Answer.* 22·238...years. (1888.)

3. A man whose income is £900 a year insures his life at the rate of £3 10s. for £100 for such an amount that at his death his heir may receive a sum whose interest at 4 p.c. per annum is equal to the man's reduced income. What annual premium is paid? *Answer.* £420. (1888.)

4. If $a : b$ as $c : d$, show that $3a^2 + ab + 2b^2 : 3a^2 - 2b^2 :: 3c^2 + cd + 2d^2 : 3c^2 - 2d^2$. (1886.)

5. The sum of a number of three digits in geometrical progression is 13, and if 792 be added to the number the digits are inverted. Find the number. *Answer.* 139. (1877.)

6. A man bought a certain number of railway shares, when they were at a certain rate per cent. discount for £900, and afterwards when they were at the same rate per cent. premium sold all but one of them for £990. How many were they, and what did each cost? *Answers.* 10; £90. (1887.)

7. Solve the equation $2x^2 + 3y^2 - xy = 31$ and $x - y = 3$. *Answer.* $x = 4$ or $-\frac{1}{2}$, $y = 1$ or $-1\frac{1}{2}$. (1887.)

8. If the geometric mean between two quantities x and y be to the harmonic as $1 : n$, show that $x : y :: 1 + \sqrt{1 - n^2} : 1 - \sqrt{1 - n^2}$. (1876.)

9. Find a number which being divided by 3, 4 and 5, the remainders are 2, 3 and 4 respectively. *Answer.* 119. (1875.)

10. If one quantity vary directly as another, and the former be $\frac{3}{4}$ when the latter is $\frac{1}{2}$, find what the latter will be when the former is 9. *Answer.* 16.

11. How many words can be formed with 3 vowels and 3 consonants, if each word contain 6 letters and have the vowels in the even places? *Answer.* 36.

12. If x be real, prove that $\frac{2x - 7}{2x^2 - 2x - 5}$ can have no real value between $\frac{1}{11}$ and 1.

Answers to, and Hints upon, Questions given in August Number.

ALGEBRA.

FOR THIRD SATURDAY AND FOURTH MONDAY.

1. (*a*) Take at first two quantities a and b. Then the sum of their squares is less than the square of their sum by $2ab$. Next let there be three quantities a, b and c, and let $(a + b) = x$. Then $x^2 + c^2$ is less than $(x + c)^2$ by $2cx$; but $(x^2 + c^2)$ is greater than $a^2 + b^2 + c^2$; $\therefore$ much more is $(x + c)^2$ *i.e.* $(a + b + c)^2$ greater than $a^2 + b^2 + c^2$.

(*b*) This is a good illustration of the foregoing theorem, viz., that if any number be divided into parts, the square of the whole is greater than the sum of the squares of each part.

2. (*a*) Write the equation as $a + 1 = \frac{42}{a}$ where $x^2 + x = a$.

Thence a or $x^2 + x$ will be found to equal 6 or -7. The -7 may be rejected as unreal, and from the value 6 we obtain $x = 2$ or -3.

(*b*) $\frac{y}{x} + \frac{1}{xy} = \frac{20}{3}$; $xy + \frac{x}{y} = \frac{4}{3}$

$\frac{y}{x} + \frac{1}{xy} = \frac{20}{3}$; $\frac{y}{x} + \frac{1}{xy} = \frac{5}{3x^2}$

$\therefore \frac{20}{3} = \frac{5}{3x^2}$

Hence $x = \frac{1}{2}$ and $y = 3$.

3. (*a*) A.M. $= \frac{a + b}{2}$, G.M. $= \sqrt{ab}$, H.M. $= \frac{2ab}{a + b}$

(*b*) What we have to show is that $\frac{a}{b}$, $\frac{a + c}{b + d}$, $\sqrt{\frac{ac}{bd}}$, $\frac{c}{d}$ are in order of [say] ascending magnitude.

Now we know that if $\frac{a}{b} = \frac{c}{d}$ then $\frac{a + c}{b + d}$ would also equal them both, but by hypothesis $\frac{c}{d}$ is greater than $\frac{a}{b}$, *i.e.*, $c : d$ in a greater ratio than $a : b$. $\therefore (a + c) : (b + d)$ in a greater ratio than $a : b$ and a less ratio than $c : d$.

Again $\left(\frac{a}{b}\right)^2$ is less than $\frac{ac}{bd}$ because $\frac{a}{b}$ is less than $\frac{c}{d}$. $\therefore \frac{a}{b}$ is less then $\sqrt{\frac{ac}{bd}}$.

Once more $\left(\frac{c}{d}\right)^2$ is greater than $\frac{ac}{bd}$ because $\frac{c}{d}$ is greater than $\frac{a}{b}$. $\therefore \frac{c}{d}$ is greater than $\sqrt{\frac{ac}{bd}}$.

4. 120 lbs.

5. By dividing $x^3 + ax^2 + bx + 10$ by $x + 2$ we get $x^2 + (a - 2)x + (b - 2a + 4)$ as Quotient and $2 - 2b + 4a$ as Remainder. But by hypothesis this remainder $= 0$.

$\therefore 2 - 2b + 4a = 0$; $\therefore 4a + 2 = 2b$; $\therefore 2a + 1 = b$. Q.E.D.

6. (*a*) $108\frac{1}{3}$; (*b*) $3\left(\frac{\sqrt{3^6} - 1}{\sqrt{3} - 1}\right)$

7. $73\frac{1}{3}$ yards.

8. By hypothesis $(ax + by) = 1$. Now $(bx + ay) - ay - bx = 0$; $\therefore (ax + by)(bx + ay) - ay - bx = 0$; $\therefore abx^2 + aby^2 + a^2xy + b^2xy - ay - bx = 0$; $\therefore abx^2 + aby^2 + a^2xy + b^2xy + ax - ay + by - bx = 1$; $\therefore ab(x^2 + y^2) + xy(a^2 + b^2) + (a - b)(x - y) = 1$.

ARITHMETIC.

Females.

FOR FIRST AND SECOND FRIDAYS.

1. All decimal fractions have an *understood* denominator which is some power of 10. Therefore the only factors of such denominators are 2 and 5. Any Vulgar Fractions, therefore, whose denominations are unresolvable into these factors cannot be a terminating decimal.

2. It is here evident that £273 12s. = 12 per cent. of the purchase-money, which last therefore = £2,280.

3. $(33 \times 37 \times 43) - 1 = 52502$.

3. *To multiply by* 99; add two noughts and subtract the original number.

To multiply by 25; add two noughts and divide by 4.

To multiply by 246; beginning from the left take twice the sum of three times the first + twice the second figure + once the third figure, then twice the sum of three times the second figure + twice the third figure + once the fourth figure, etc.

To square a number (say) of three figures. Take the square of the first, then twice the product of the first and second, then the sum of the square of the second, and twice the product of the first and third, lastly, the square of the third. Set down a figure at each step, and add on the 'carriers.'

To find the interest on money for years and months at 2½ per cent. This is at the rate of ½d. per £ per month. Therefore we must multiply the number of pounds by number of months, and the answer will be halfpence.

5. 325 yards further.

6. $39\frac{1}{13}$ per cent.

7. £$27\frac{123}{611}$.

8. £$17\frac{611}{611}$ per cent.

EUCLID.

FOR SECOND SATURDAY.

2. LMS = ¼ of LMN; and LRS = ¼ of LRN, ∴ LMSR = ¼ of LM².

Again $\overline{LS}^2 = \frac{1}{16}$ of $\overline{LN}^2$ or ¼ of $\overline{LM}^2$ ∴ LMSR = 2 $\overline{LS}^2$.

3. Let ABC be a triangle having side AB = side AC. From B draw BD perpendicular to AC.

Then $\overline{BD}^2$ shall = $\overline{DC}^2$ + 2 AD.DC.

Proof.—$\overline{AB}^2 = \overline{AC}^2$

but $\overline{AB}^2 = \overline{AD}^2 + \overline{DB}^2$; and $\overline{AC}^2 = \overline{AD}^2 + \overline{DC}^2$+2AD.DC

∴ $\overline{AD}^2 + \overline{DB}^2 = \overline{AD}^2 + \overline{DC}^2$ + 2 AD.DC.

Take away from each side $\overline{AD}^2$

∴ $\overline{DB}^2 = \overline{DC}^2$ + 2 AD.DC. Q.E.D.

4. Let PSQR be a circle having its centre at O. Let PQ and RS be = chords intersecting at J. If JO be joined, the angle RJO shall be equal to the angle PJO.

Construction.—From O drop perpendiculars to RS and PQ meeting them respectively in A and B.

Proof.—∵ RS = PQ, ∴ OA = OB and $\overline{OA}^2 = \overline{OB}^2$, and ∵ OJ is the common hypotenuse,

∴ $\overline{OA}^2 + \overline{AJ}^2 = \overline{OB}^2 + \overline{BJ}^2$; but $\overline{OA}^2 = \overline{OB}^2$, ∴ $\overline{AJ}^2 = \overline{BJ}^2$ and AJ = BJ.

∴ triangle AJO has all its sides = to those of BJO, ∴ angle AJO = angle BJO.

5. Let the circles AZB and YZC touch each other externally at Z; and let AXY be a common tangent and let ZX be the common tangent at Z drawn to meet AXY in X.

Then AX = AY.

Proof. ∵ XZ and XA are both tangential to AZB, ∴ XZ = XA; and

∵ XZ and XY are both tangential to YZC, ∴ XZ = XY.

∴ XA = XY. Q.E.D.

6. A circle passes through four points A, B, C, D; under what conditions will the angle ABC = the angle ADC?

∵ ABC and ADC are opposite angles, their sum is equal to two right angles, and ∵ ABC = ADC *each* of them is half of two right angles or one right angle. ∴ AC must be a diameter, that is, ADC and ABC are semicircles.

7. Let ABC be a triangle rightangled at B. (Do not make it isosceles.)

Let ABCD be the circumscribed circle, and XYZ the inscribed circle touching the sides AB, BC and CA respectively at X, Y and Z.

Then the sum of the diameters of these circles is equal to the sum of the two sides of the triangle.

Construction. Take O and P, the centres of the circumscribed and inscribed circles respectively. Join PX and PY.

Proof. PX and PY = the diameter of XYZ, and PX and PY are respectively perpendicular to AB and BC and ∴ respectively parallel to BC and AB.

∴ BP is a parallelogram and PX + PY = YB + BX, ∴ diameter of XYZ = YB + BX.

Again. The hypotenuse AC is the diameter of ABCD, since ABC is a right angle; and

∵ AX and AZ are tangents to XYZ, ∴ AX = AZ.

Similarly, ∵ CZ and CY ,, ,, ∴ CZ = CY.

∴ AZ + ZC, *i.e.*, the diameter of the circumscribed circle is = AX + CY,

∴ the sum of the two diameters = YB + BX + AX + CY, *i.e.*, the sum of the sides. Q.E.D.

This deduction is frequently thus enunciated, 'In any right-angled triangle the diameter of the inscribed circle is = to the difference between the sum of the sides and the hypotenuse.'

CORRESPONDENCE.

1. *We shall be pleased to reply briefly and through this column to any seeking information or advice. Endorse* 'CERTIFICATE EDITOR' *if the office be communicated with.*

2. *Replies demanding urgency will be promptly forwarded per post on receipt of stamped and directed envelope. This privilege does not extend to furnishing solutions and answers to examination questions. A post will be saved by addressing direct to Macclesfield. Upwards of one hundred letters were thus answered during 1889.*

3. *Any suggestions tending to the greater utility and interest of these articles, or to the greater convenience of* 'COACH' *or* PUPIL, *will be thankfully received and thoughtfully considered.*

4. We are repeatedly being asked, '*Is Herbert Spencer still living?*' The following extract from '*Tit Bits*' may be interesting.—Herbert Spencer, the greatest philosopher of the age, is now seventy years old. He is unmarried, lives alone in a boarding house, and has but few intimate friends. Contrary to the usual idea, he is not a University man; and although one of the greatest thinkers in the world, he is not widely read, as he pays little attention to his literary style, writing frequently in an incomprehensible vein. He hardly makes enough from his books to support his life of extreme simplicity. He has always been more or less of an invalid.'

5. E. S. (Barrow), 'M.' (Nottingham), J. W. V. (Bilston), UNCLE (Truro), W. H. R. (Newcastle-on-Tyne), 2 letters, P. O. (Darlington), W. (Penrith), S. P. T. (St. Helen's), C. C. (The Hyde, London), K. R (Bloomsbury), SAM (Leek), E. P. (Lark Lane), W. R. (Macclesfield), MUSIC (Smethwick), A. M. (Middleton), SOL (Liverpool), J. J. (Boston), J. T. J. (Ruabon), answered per ordinary letter.

6. SNAIL (Brighton), See p. 167; R. T. (Birmingham), The new Schedules provide for the record of different classification in the '*3 R's.*' *(Hednesford), You are old enough. Get your correspondent to write at once. QUERY (Neath), From any educational bookseller; I. G. N. (S. Shields), You could not be ready in time; G. (Dover), See March Number; 'LIZZY,' You are duly qualified; M. P. J. (Holborn), Both books.

(To be continued.)

Practical Perspective for Pupil Teachers.

BY

E. G. BAKER, B.SC., B.A.,

Vice-Principal of the Training College, Carmarthen.

V.

THE height line is useful for ridges, and also for obtaining points on vertical surfaces, as will be seen from the two problems solved in Fig. 38, which should be re-worked.

1. Place in perspective a right triangular prism the ends of which are equilateral triangles with sides 3 ft. long. The prism rests on one of its rectangular faces on the ground plane. Its axis, which makes an angle of 45° with the picture plane, is 5 ft. long, and the nearest corner of the rectangular base is 3 ft. to the left and 1 ft. in the picture.

2. Place the same solid in perspective supposing it to stand on one of the triangular ends, the nearest angle on the ground plane being 4 ft. to the right and 1 ft. in the picture, and one side of the base vanishing to the right at 45°.

On the two visible faces of this solid and in their centre place a square with sides $1\frac{1}{2}$ ft. long, that on the right-hand face having two sides horizontal, and that on the left-hand face having a diagonal horizontal.

N.B.—For the above problems the spectator is supposed to be 5 ft. high, and to stand 8 ft. away from the picture plane.

of the ridge above C, construct the equilateral triangle ABE. This is the end elevation, and CE is the height required. Use a height line FG = CE, and one end of the ridge will be found. Draw a line from that end to the VP on the right to meet the perpendicular from the centre D of the other end of the base. Join the two extremities of the ridge to the corners of the base and the solid is projected.

In Problem 2, the plan is an equilateral triangle, and since the height of the solid is 5 ft., *i.e.*, the same as the height of the

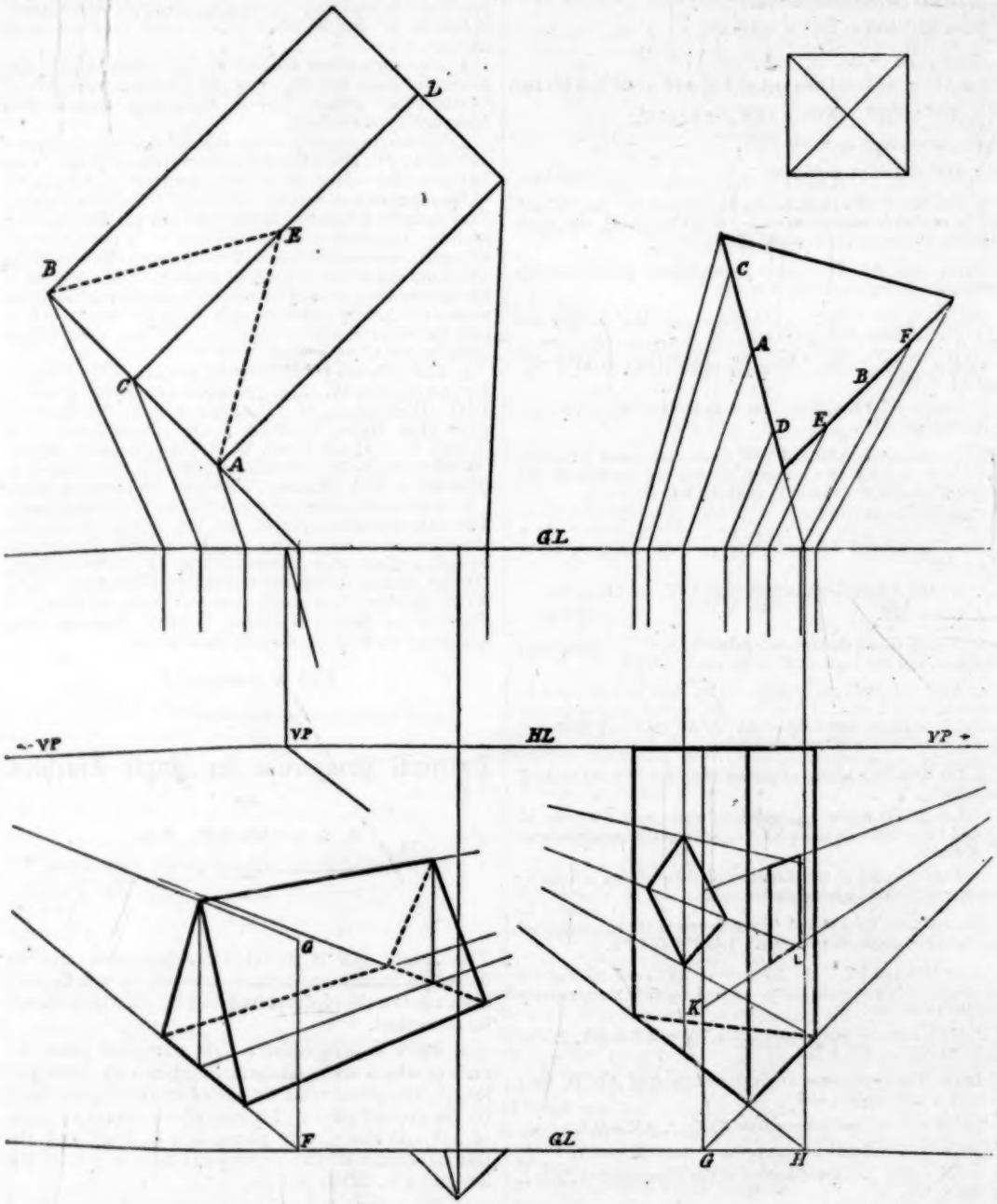


Fig. 38.

NOTE.—The ground plan of the prism in Problem 1. will be a rectangle 3 ft. by 5 ft. On this plan the ridge will be shown by a straight line CD through the centre of the rectangle. First put the whole rectangle in perspective. Then, to find the height spectator, the top will be on the level of the eye and so will be a straight line when projected. All, therefore, that has to be done is to project the base and raise perpendiculars from its corners to meet HL.

Draw somewhere the small square which has to be put on each visible face. Make AC and AD half the diagonal and BE, BF half the side. The points A and B are the centres of the two sides of the triangle. Use the height line at G for the square on the right-hand face. Since the square has to be in the centre of the face, and its side is $1\frac{1}{2}$ ft., make GK $1\frac{3}{4}$ ft.

For the square on the left-hand face, use the height line at H. Make HL $2\frac{1}{2}$ ft. and the line from L to VP is the line in which the horizontal diagonal lies. On each side of L cut off a distance equal to half the diagonal. The figure will show the method of obtaining the four corners of the square.

The student should note that by using a height-line we get two parallel horizontal lines in a vertical plane, which, of course vanish to the same point. Now, if a perpendicular line be drawn anywhere between these two lines it is the projection of a line of the same height as the height-line.

PROBLEMS.

Scale $\frac{1}{2}$ in. to the foot.

1. Fig. 39 is the front elevation to full scale of a slab 1 ft. thick, on the nearer vertical face of which is a square. Place the whole in perspective so that A may be 4 ft. to the left and 1 ft. in the picture, and the side AB of the base may make an angle of 40° with the picture plane towards the right. The spectator is 10 ft. from the picture plane and 4 ft. high.

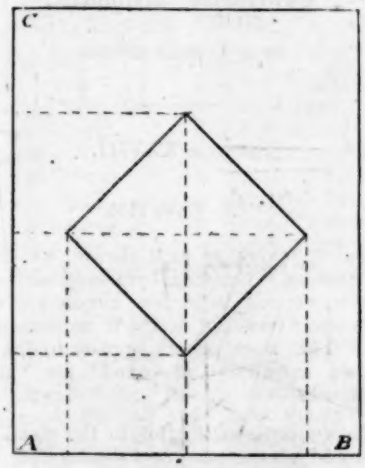


Fig. 39.

N.B.—The plan will be a rectangle, two sides of which are equal to AB, and the other two 1 ft. by scale. The intersections of the dotted lines give the corners of the square. The distances along AB will be shown on the plan, and those along AC on the height line.

2. Fig. 40 is the front elevation to full scale of a vertical slab standing on the ground plane. The slab is $1\frac{1}{2}$ ft. thick, and the point A of the base is 2 ft. to the right and 1 ft. in the picture, while AB vanishes to the right at 40°. On the vertical face nearer the picture plane is drawn a hexagon as shown in elevation. Place the whole in perspective as seen by a spectator 5 ft. high and 10 ft. from the picture plane.

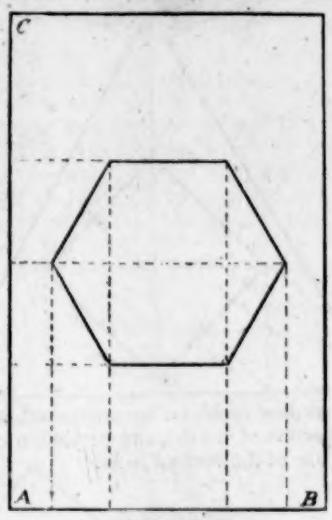


Fig. 40.

N.B.—The intersections of the dotted lines are obtained by the same means as in Problem 1.

3. Fig. 41 is the end elevation to full scale of a right triangular prism standing on one of its faces on the ground plane. The prism is 4 ft. long, and the corner A of the base is 1 ft. to the left and touching the picture plane, while AB recedes from the picture plane towards the left at 45°. On the triangular end nearer the picture plane is drawn a square as shown in elevation. Draw the perspective projection for an eye 9 ft. from the plane of projection and 4 ft. above the ground plane.

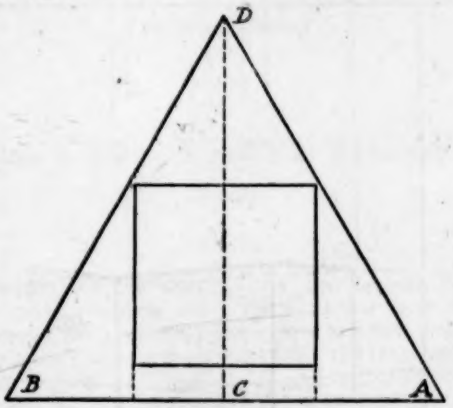


Fig. 41.

N.B.—The distances along AB will be shown in plan, and those along CD on the height line. The plan will be a rectangle two sides of which are equal to AB, and the other two sides 4 ft. long.

4. Fig. 42 is the end elevation to full scale of a right prism 4 ft. long, standing on one of its rectangular faces on the ground plane.

The corner A of the base is 3 ft. to the right and 2 ft. in the picture and AB is inclined to the ground line at an angle of 30°. On the nearer triangular end is drawn a square as shown in elevation. Place the whole in perspective for a spectator 10 ft. from the picture plane and 4 ft. high.

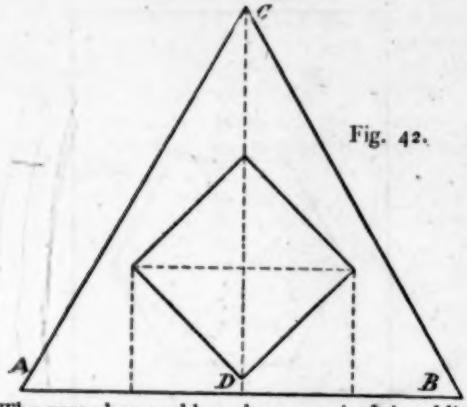


Fig. 42.

The preceding problems have required, in addition to the projection of a solid, the projection of a figure drawn on one of the vertical faces.

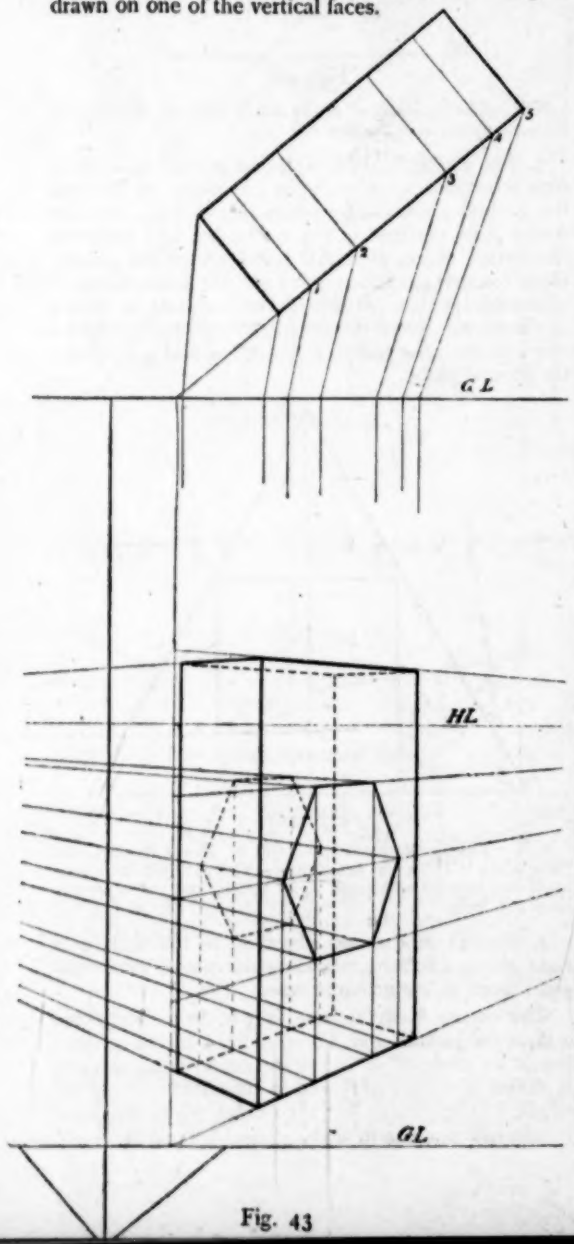


Fig. 43

Fig. 43 shows how to obtain a figure on the opposite vertical face also, when the two figures are exactly opposite each other and alike. The elevation is that given in Fig. 40, the solid being the same as in the Problem to Fig. 40, except that the elevation is now to be regarded as the elevation of two opposite vertical faces.

The hexagon on the front is obtained exactly as in that problem. To obtain the hexagon behind we have to draw on that face perpendiculars corresponding to those in front. The corners of the hexagon are on these perpendiculars, and are the points of intersection of the lines from the corners of the front hexagon to the VP on the left and these perpendiculars.

The drawing will explain itself if the student re-work the Problem.

As exercises similar to the last the student should project the solids whose elevations are given in Figs. 39, 41 and 42, it being now supposed that the squares are drawn on two opposite faces and not on one face only.

(To be continued.)

—o—

Contracted Arithmetic.

BY J. L. RICHARDSON.

SECTION XXVIII.

Division by 99, 999, &c.

IF, instead of taking 99 as a divisor, we divide by 100, the quotient is too small by a hundredth of itself. If, however, we add to it this hundredth, we shall have the correct result, or nearly, to an inconsiderable decimal. The same remark applies to the divisor 999, if we substitute 'thousand' for 'hundred.' Hence the rule :—

Cut off two, or three, figures to the right, and to the result add a hundredth, or a thousandth, of itself. If strict accuracy be required continue the process to two or three decimal places, which will be best done by moving the decimal point as in ordinary division of decimals.

Example :—

$3846 \div 99 = (3846 \div 100) + (38{\cdot}46 \div 100) = 38{\cdot}84$. Ans.

Dividing 3846 by 100 we cut off 46, leaving 38·46. Dividing the latter again by 100 we have ·3846. The two results combined give 38·8466. If, for the sake of greater accuracy, we yet again divide the ·3846 by 100 we obtain ·003846, and on adding together these results we get the answer 38·848446, as in the annexed working, which is of course equivalent to 38·84.

EXERCISE XXXI.

(Work to two decimals, and augment by one the right hand decimal figure.)

By 99. 1. 38,476. 2. 28,435. 3. 976,238.
4. 456,789. 5. 502,360. 6. 589,630.
7. 384,025. 8. 8,023. 9. 921,476.
10. 28,635.

By 999. 11. 381,467. 12. 583,652. 13. 368,976.
14. 248,560. 15. 58,276. 16. 3,102,586.
17. 796,423. 18. 587,623. 19. 45,804.
20. 76,305.

SECTION XXIX.

Division by Cancelling.

When divisor and dividend are common multiples of any number, the labour of division is lightened by first cancelling out that number. Thus in 9684 ÷ 144 we see that 12 is contained in each, and we may cancel out by that number when we have instead of the original terms 807 ÷ 12, which can be done by short division.

Example:—

144)9684(
12) 807
67 + 3. Ans.

Work, by cancelling, the following:—

EXERCISE XXXII.

1. 384 ÷ 32. 2. 5,890 ÷ 25.
3. 816 ÷ 214. 4. 9,876 ÷ 5,236.
5. 218,634 ÷ 3,162. 6. 960 ÷ 144.
7. 7,645 ÷ 245. 8. 2,856 ÷ 1,071.
9. 65,418 ÷ 1,242. 10. 982,827 ÷ 387.
11. 35,756 ÷ 154. 12. 39,995 ÷ 1,140.
13. 76,234 ÷ 482. 14. 35,178 ÷ 249.
15. 38,240 ÷ 248. 16. 7,642,315 ÷ 2,890.
17. 2,680 ÷ 146. 18. 8,127 ÷ 45.
19. 75,105 ÷ 1,545. 20. 11,552 ÷ 7,638.

SECTION XXX.

'Italian' Division.

In what is called the 'Italian' method the work is shortened by performing it to a great extent mentally, and putting down only the remainders at each step, with, of course, the 'bringing down' figures. An illustration of the process is given in (*a*), where the products of 381 by 4, 8 and 3 are, digit by digit as they arise, taken mentally from the successive dividends, and only the remainders put down. The various stages may be better understood on comparison with the fully worked Example (*b*). The method is an excellent one for strengthening the faculty of mental computation.

(*a*)

381)184267(483
3186
1387
244

(*b*)

381)184267(483
1524
3186
4048
1387
1143
244

EXERCISE XXXIII.

1. 3,804 ÷ 240. 2. 6,872 ÷ 314.
3. 58,420 ÷ 685. 4. 57,623 ÷ 582.
5. 71,896 ÷ 326. 6. 41,379 ÷ 742.
7. 15,963 ÷ 479. 8. 38,246 ÷ 745.
9. 79,004 ÷ 615. 10. 43,561 ÷ 726.
11. 42,517 ÷ 674. 12. 98,274 ÷ 513.
13. 34,567 ÷ 749. 14. 456,278 ÷ 984.
15. 562,790 ÷ 689. 16. 47,923 ÷ 648.
17. 91,987 ÷ 704. 18. 781,902 ÷ 827.
19. 829,730 ÷ 719. 20. 604,098 ÷ 483.

ANSWERS.

EXERCISE XXXI.

1. 388·64. 2. 287·22. 3. 9860·98. 4. 4614·03.
5. 5074·34. 6. 5955·85 7. 3879·04. 8. 81·04.
9. 9307·03. 10. 289·24. 11. 381.85. 12. 584·24.
13. 369·34. 14. 248·81. 15. 58·33. 16. 3105·69.
17. 797·22 18. 583·21. 19. 45·85. 20. 76·38.

EXERCISE XXXII.

1. 12. 2. 235$\frac{5}{15}$. 3. 31$\frac{87}{100}$. 4. 1$\frac{1112}{1389}$.
5. 69$\frac{7.6}{1111}$. 6. 6$\frac{1}{3}$. 7. 31$\frac{10}{19}$. 8. 2$\frac{1}{3}$.
9. 52$\frac{1134}{1242}$. 10. 2539$\frac{81}{387}$. 11. 232$\frac{7}{11}$. 12. 35$\frac{1}{19}$.
13. 155$\frac{270}{482}$. 14. 141$\frac{129}{249}$. 15. 154$\frac{80}{248}$. 16. 2644$\frac{202}{2890}$.
17. 18$\frac{28}{73}$. 18. 180$\frac{3}{5}$. 19. 48$\frac{90}{1545}$. 20. 1$\frac{3917}{7638}$.

EXERCISE XXXIII.

1. 15 + 204. 2. 21 + 278. 3. 85 + 195.
4. 99 + 5. 5. 220 + 176. 6. 55 + 569.
7. 33 + 156. 8. 51 + 251. 9. 128 + 284.
10. 60 + 1. 11. 63 + 55. 12. 191 + 291.
13. 46 + 113. 14. 463 + 686. 15. 816 + 566.
16. 73 + 619. 17. 130 + 467. 18. 945 + 387.
19. 1,154 + 4. 20. 1,250 + 348.

(To be continued.)

—o—

How a Scotch School was Examined.

INFANTS.

Reading.—Three classes—only the highest class examined in reading—each one read two short sentences. A few questions were given to test intelligence, and some oral spelling completed the Inspector's work.

Writing.—Highest class wrote a few words dictated by the Inspector, while the others wrote the capital and small letters.

Arithmetic.—First class set on slates 19, 9, 15, 50, 60, and 17, and the others answered questions in addition and subtraction as follow:—2 and 6? 3 and 9? 4 and 7? 8 and 6? 2 chairs have how many legs? 3 horses how many legs? 4 from 10? 3 from 11? 7 from 10? How many half-penny oranges for 3d.?

Object Lesson.—On the 'Tiger.' Lesson from a Junior Pupil Teacher on Form.

Music.—One action song. Test on Modulator.

STANDARD I.

Reading.—Graduated Reader, page 74, 'Wheat.' Each one read a sentence and then questions were asked on the scope of the lesson. One word each round the class satisfied for spelling.

Writing.—(*a*) Then it will be put into a thrashing-mill. (*b*) When the sun has dried the grain.

Arithmetic.—

A. (1) 730 + 500 + 409 + 975 + 848.

(2) 987 + 786 + 534 + 894 + 99.

(3) Take 99 from 701.

B. (1) 604 + 700 + 209 + 901 + 50.

(2) 789 + 687 + 435 + 498 + 88.

(3) From 901 take 197.

Music.—Same as Infants.

STANDARD II.

Reading.—Chambers' Graduated, page 80, 'The Crippled Sparrow.' Each read a sentence and then questions were asked about the sparrow.

One was asked to pick the nouns out of par. 1, another to find the verbs in par. 2, and a third, the adjectives in par. 3.

A lesson was also read from Star Reader, No. 2.

Writing.—'Then the whole flock began to chatter at a great rate, and at last three or four flew away. Soon one came back with a twig about four inches long.'

Arithmetic.—(1) 9287 + 789 + 6809 + 7935 + 5989 + 6789 + 9879.

(2) From 9,867,453 take 987,675.

(3) Multiply 876,953 by 6.

STANDARD III.

Reading.—Star Reader, page 135, 'Two pictures for Idle Boys.' Each pupil read a sentence or more and answered questions on meanings of words and phrases.

Analysis.—Such sentences were given as follow:—'Then you must have met it.' 'I shall show it to him in two pictures.' 'Now look at the work he has done.' 'His neighbours are busy.'

Writing.—'A countryman was once driving his cart along a road. The wheels stuck so fast in the mud that the horse could not draw them out. Instead of doing his best to move the cart, the driver fell on his knees and prayed to Hercules to come and help him.'

Arithmetic.—

A. (1) Multiply 897,390 by 7,600 (words).

(2) Divide 1,987,634 by 297.

(3) Divide 296,437 by 84 (factors).

(4) Subtract £92 18s. 6½d. from £1000 15s.

B. (1) Multiply 987,309 by 8703 (words).

(2) Divide 7,346,259 by 89.

(3) Divide 1,893,462 by 479.

(4) Take £79 13s. 4¾d. from £901 10s. 11¼d.

Geography.—Boundaries of Scotland—Counties on east coast—counties on Solway—mountains in Lowlands—rivers rising in Lowthers—rivers in Dumfriesshire—in Aberdeenshire—lakes in Perthshire—largest lake in Scotland—highest mountain—where is Tinto?—Ben Attow?—largest city—capital—where is Dundee?—Greenock, &c.

History.—Life of Bruce.

Repetition.—Wreck of the Hesperus.

STANDARD IV.

Reading.—Star Reader, page 88, 'A Beaver Town' and 'Flowers,' page 121. Each pupil read as in Standard III. Questions given on word and phrase.

Parsing.—'Everybody likes flowers.'

Analysis.—'Charney guarded his plant with great care.' 'Perhaps some one had carelessly dropped a seed.' 'One day there was a hail storm,' &c.

Repetition.—Llewelyn and his Dog.

Writing.—'In the depths of the thick forests and near the banks of lonely rivers, the sable loves to make its burrow; or collecting withered leaves and dry grass, it builds its nest in the hollow of a tree. Here during the brief summer it watches and waits for the timid hare; and in winter, feeds on the wild berries that cluster in abundance around its home. The fur of the sable is of a rich brown colour, tinged with gray about the neck.'

Arithmetic.—

A. (1) Multiply £291 17s. 8½d. by 890.

(2) Divide £3916 15s. 7½d. by 79.

(3) Reduce 98,765 pints to gallons.

(4) How many books at 3s. 4d. each, can be paid for with £9 13s. 4d.?

B. (1) Multiply £973 14s. 8¾d. by 97.

(2) Divide 17,063 12s. 4¼d. by 196.

(3) How many ounces are there in 6 cwts. 79 lbs.

(4) Reduce £91 8s. 6d. to three-pences.

History.—A general outline from James I. to the death of Charles II.

Geography.—*Ireland*—rivers, mountains, chief towns. *England*—centres of industries

STANDARD V.

Reading.—Star Reader, page 59. The story of George Stephenson. Great attention paid to phrasing and rhetorical pausing.

Parsing, &c.—Meaning of 'locomotive,' 'Parliament,' 'directors,' 'Prime Minister.' Name any Prime Minister, 'Constable.' Where is Darlington? Stockton? Manchester? *Parse* Manchester (*paragraph 1*). Who will parse 'miles' in first line? 'centre?' (*a*) 'cotton?' (*b*) 'cotton?' 'is sent,' is what form of the verb? 'which.'

What kind of a sentence is 'which the mills turn out' (adj. sent. qual. 'goods').

Writing.—

THE BONY DETECTIVE.

Two burglars broke into a surgeon's house. They found their way into his private room, which they plundered. One opened a large press and began to search for any-thing of value. While groping about in the dark, his hands got firmly fixed in the jaws of a skeleton. Its jaws were so arranged, that if disturbed, they would suddenly shut by means of a spring. This spring the robber had accidentally touched, and his hand was gripped as in a machine. He screamed with pain and his surprised companion turned his lamp upon him. When the light fell upon the skeleton, the robber saw it and fell senseless on the floor, dragging the skeleton with him. The crash frightened the other robber with the lamp and he quickly jumped through the window. The surgeon came down and kept his prisoner fast until the arrival of the police.

Arithmetic.—

A. (1) Find by practice the value of 549$\frac{1}{3}$ articles at £3 17s. 3$\frac{3}{4}$d. each.

(2) Make out the following bill:—

27$\frac{1}{2}$ yds. linen at 5s. per yd.
19$\frac{3}{4}$ yds. cotton at 2s. 4d. per yd.
72 reels at 4$\frac{1}{2}$d. per dozen.
100 bobbins at $\frac{1}{2}$d. each.

(3) Find the price of 2 stones 3$\frac{1}{2}$ lbs., if 2 cwts. 1 qr. 4 lbs. cost £9 1s. 4d.

(4) Divide $\frac{1}{3}$ of 3$\frac{1}{2}$ by $\frac{7}{8}$ + $\frac{3}{5}$.

B. (1) Find by practice the value of 317 articles at £2 11s. 10$\frac{1}{2}$d. each.

(2) Make out the following bill:—

43 lbs. cheese at 6$\frac{1}{2}$d. per lb.
4 score eggs at 4$\frac{3}{4}$d. for 5.
70 lbs. sugar at 5$\frac{1}{4}$d. per lb.
7 hams, each 12$\frac{1}{2}$ lbs., at 11$\frac{1}{2}$ per lb.

(3) If 5 cwts. 7 lbs. be carried 42 miles for 9s. 4d., how far will 2 cwts. 2 qrs. be carried for the same sum?

(4) Add 4$\frac{1}{3}$ to 2$\frac{2}{5}$ and divide the result by $\frac{3}{5}$ of 4$\frac{1}{2}$.

Geography.—Draw maps: 1, Italy, 2, The Peninsular, 3, Australia. Answered questions on Europe—Rivers flowing into Baltic, into Atlantic. Islands in Baltic, in Mediterranean. Course of the Rhine, of the Danube, of the Volga. Towns on the Bay of Biscay, on the Black Sea, on the Rhine.

History.—Reign of George III.—Seven Years' War—War of Independence—Napoleon—Peninsular War—Battles of Waterloo and Trafalgar very particularly.

Repetition.—Lines from Scott's 'Flodden.' Meaning of words and phrases particularly tested. Geographical allusions also commented on.

STANDARD VI.

Reading.—Century Reader VI., page 64, 'A Maid of Arcadia.' As the class was not large, each pupil read a paragraph, and as in Standard V., great attention was paid to pausing and phrasing.

Intelligence, &c.—What is meant by 'leashes'? 'unlike'? other words beginning with un, 'uncoupled'? 'methodical'? 'encouraged'? 'disconcerted'? Where do 'anemones' grow? What is a scroll? 'engrossed in her book'?

Par. 2.—Parse 'forwards'—'till'—'began'—'encouraged'—'who'—'as'—'huntsman.' Analysis of 2nd sentence in par. 2 and the 1st of par. 4.

Writing.—Essay on 'Summer.' A letter on 'How the last holidays were spent,' or 'A school trip.'

Arithmetic.—

A. (1) Simplify $\frac{\cdot 10\frac{1}{2} - 2\frac{3}{4}}{\cdot 4 - \cdot 25}$ and express the result as a decimal fraction.

(2) If four tons of hay serve 7 cows for 50 days, how long will 6 tons serve 9 horses; supposing 5 cows to eat as much as 3 horses.

(3) Express $\frac{1}{1\frac{1}{20}}$ of 1 cwt. as the vulgar fraction of a ton and of a lb.

(4) Find the simple interest of £375 for 3 years 3 months at 4$\frac{1}{4}$ per cent.

B. (1) Find by practice the dividend of £1584 17s. 6d. at 13s. 10d. in the pound.

(2) What is the value of ·3125 of 1s. − ·7 of £1 + ·2 of 4s. 6d. − ·3 of 16s. 3d.

(3) Simplify $\frac{6\cdot 25 \text{ of } 3\frac{3}{8}}{11\frac{1}{3} - 6\cdot 7} \div 3\cdot 03$.

(4) What sum will amount to £630 11s. 3d. in 5 years at 2$\frac{1}{2}$ per cent.?

C. (1) In what time will £136 17s. 6d. put out at 10 per cent. interest amount to £140 10s. 3d.?

(2) Simplify $\frac{\frac{9}{11} + (2\frac{3}{5} - \cdot 75) - \frac{9}{15}}{\frac{17}{21} \div 6\cdot 8}$

(3) In what time will 120 men build a wall 40 feet, if 165 men build one 55 feet high in 10 days?

(4) What ought a man to receive for the loan of £1481 5s. for 5 years; interest being 4 per cent. per annum?

History, Geography, and Repetition, taken with Standard V.

STANDARDS II.—VI.

Music.—Modulator:—Key C. **d m s m f fe s s s fe f m r d r s t d' m f fe s l s fe l s fe f m r d.**

Key D.—**d m s d' d' ta l s 'd r t, d f m r l 'd' t d' m f l s ta ta l s t d' f m.**

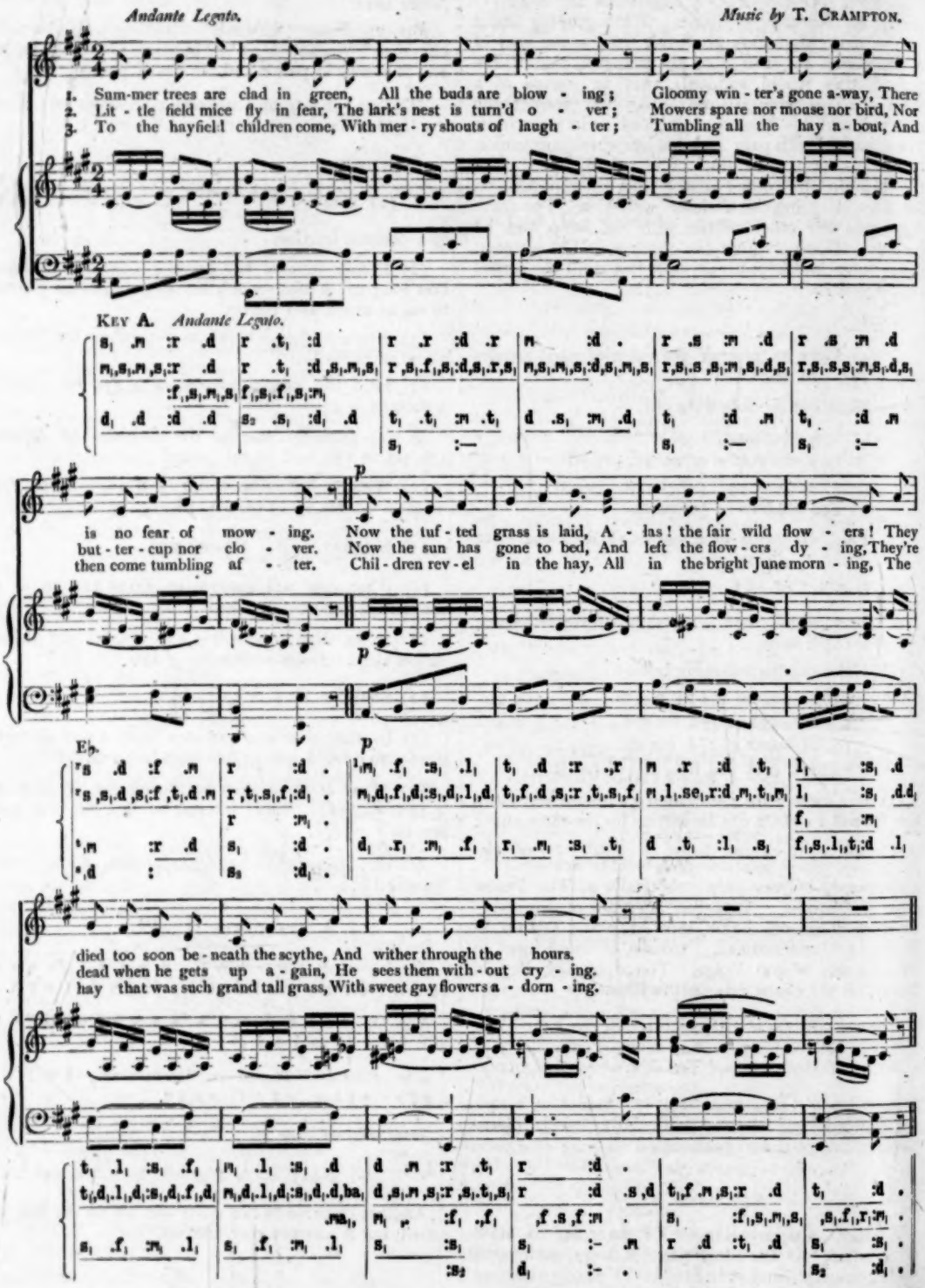
Ear Exercise.—Played on Harmonium.—**l r f m; m s f r; s f l m; r f l s; m m r d.**

Time Test.—

| 1 :— :— | — :— :1 | 1 .1 :1 .1 :1 | 1 : :1 ‖

Another exercise in two parts was set on the Blackboard, but it was not very difficult.

HAY-TIME.

Andante Legato. *Music by* T. CRAMPTON.

1. Sum-mer trees are clad in green, All the buds are blow - ing; Gloomy win - ter's gone a-way, There
2. Lit - tle field mice fly in fear, The lark's nest is turn'd o - ver; Mowers spare nor mouse nor bird, Nor
3. To the hayfield children come, With mer - ry shouts of laugh - ter; Tumbling all the hay a - bout, And
KEY A. Andante Legato.
p
is no fear of mow - ing. Now the tuf - ted grass is laid, A - las! the fair wild flow - ers! They
but - ter - cup nor clo - ver. Now the sun has gone to bed, And left the flow - ers dy - ing, They're
then come tumbling af - ter. Chil - dren rev - el in the hay, All in the bright June morn - ing, The
E♭.
died too soon be - neath the scythe, And wither through the hours.
dead when he gets up a - gain, He sees them with - out cry - ing.
hay that was such grand tall grass, With sweet gay flowers a - dorn - ing.

Query Column.

RULES.

1. **Each correspondent is restricted to *one question*.** We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. C. R.—The difference between the interest and the discount is $\frac{1}{25}$ of the sum of money discounted, and the rate is 4 per cent. Find the time.

(*Capel's* 'Catch Questions in Arithmetic and Mensuration.')

This question cannot be worked by pure Arithmetic, since an unknown quantity is involved as a factor in a term.

At 4 per cent. for one year the difference is $\frac{4}{100} - \frac{4}{105}$ of the principal

$$= 4 \times \frac{4}{100 \times 104} \text{ of the principal;}$$

Similarly for 2 years the difference is

$$2 \times 4 \times \frac{2 \times 4}{100 \times 108} \text{ of the principal;}$$

And therefore for t years the difference is

$$t \times 4 \times \frac{t \times 4}{100 \times [100 + (t \times 4)]} \text{ of the principal;}$$

$$\therefore \tfrac{1}{25} \text{ of principal} = 4t \times \frac{4t}{100 \times (100 + 4t)} \text{ of principal,}$$

$$\tfrac{1}{25} = \frac{16t}{10{,}000 + 400t},$$

$$\tfrac{1}{25} = \frac{16t}{1{,}000 + 40t}$$

$$= \frac{2t}{125 + 5t},$$

$$125 + 5t = 6t,$$

$$6t - 5t = 125,$$

From which it can be ascertained *by trial* that $t = 5$.

$\therefore$ Time = 5 years. Ans.

Note.—This is really a question in Algebra, and the time can be found from the quadratic equation :—

$$6x^2 - 5x = 125.$$

2. JOSEPHUS.—Reduce $\frac{2603616}{16583392}$ to its lowest terms.

Find G. C. M. of 2603616 and 16583392.

2603616	16583392
1923392	15621696
680224	961696
562944	680224
117280	281472
93824	234560
23456	46912
	46912

$\therefore$ 2602616 $\div$ 23456

$\therefore$ 16583392 $\div$ 23456

$= \underline{\underline{707}}$. Ans.

3. DAMEH.—A viaduct consists of 3 series of arches built upon each other, the breadths of the arches in each being respectively 8 yds. 2 ft., 6 yds., and 5 yds. Whenever the piers in all the series are vertically above each other, there occurs a mass of masonry 4 yds. wide; of such there are three. Find the length of the viaduct. (*Hamblin Smith.*)

8 yds. 2 ft. = 26 ft.; 6 yds. = 18 ft. 5 yds. = 15 ft.

L.C.M. of 26, 18, and 15 = 1,170, and 1,170 ft. = 390 yds.;

$\therefore$ Length of viaduct = (390 yds. $\times$ 2) + (4 yds. $\times$ 3)

= 780 yds. + 12 yds.

= 792 yds. Ans.

4. HERBERTUS.—How long will it take for a train 284 feet long, moving at the rate of 25 miles per hour, to pass entirely by another 244 feet long, which is moving in the opposite direction at 35 miles per hour?

(*Naval Cadet Exam. Papers, June, 1889.*)

Sum of lengths of trains = (284 + 244) ft.

= 528 ft.,

Sum of rates of trains per hour = (25 + 35) miles

= 60 miles,

miles	ft.	hour	
$\therefore$ 60	: 528	:: 1	: Time

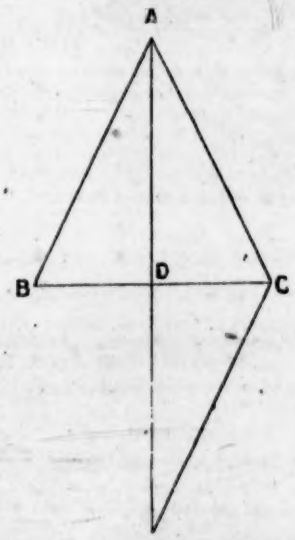
$$= \frac{528 \times 60 \times 60}{60 \times 5280} \text{ sec.}$$

= 6 seconds. Ans.

Geometry.

1. CYCLOPS.—If the same straight line bisect the base and the vertical angle of a triangle, the triangle is isosceles.

(*Charterhouse Junior Scholarship*, 1890.)



Let ABC be a triangle, and let AD bisect the vertical angle BAC and the base BC. Then the triangle ABC shall be isosceles.

Proof.—Produce AD to E, making DE = AD (I. 3), and join CE.

In triangles CDE, BDA,

CD = BD, (Hyp.)

DE = AD, (Con.)

And $\angle$ CDE = $\angle$ BDA, (I. 15.)

$\therefore$ base CE = base BA, (I. 4.)

And $\angle CED = \angle BAD$;
Now $\angle BAD = \angle CAD$, (Hyp.)
$\therefore \angle CED = \angle CAD$, (Ax. 1.)
Wherefore $CE = CA$; (I. 6.)
$\therefore AB = AC$, (Ax. 1.)
Wherefore triangle ABC is isosceles.

Q. E. D.

Algebra.

1. C. E. N.—The weight of the material of which a hollow spherical ball is made is to that of a solid spherical ball of the same diameter (4 inches) and made of the same material, as 721 : 4096. Find the thickness (supposed uniform) of the material of the hollow ball. Take the weight of a solid sphere to vary as the cube of the radius.

(*College of Preceptors' Exam., First Class, June, 1890.*)

Let x = Thickness of material of hollow sphere in inches,

Then, $2^3 - (2-x)^3 : 2^3 :: 721 : 4096$,
$:: 9^3 : 16^3$,
$2^3 - (2-x)^3 - 2^3 : 2^3 :: 9^3 - 16^3 : 16^3$,
$-(2-x)^3 : 2^3 :: -15^3 : 16^3$,
$2 - x : 2 :: 15 : 16$,
$\therefore 16(2-x) = 2 \times 15$
$8(2-x) = 15$
$2 - x = 1\frac{7}{8}$
$\therefore x = 2 - 1\frac{7}{8}$
$= \frac{1}{8}$.

$\therefore$ Thickness of hollow sphere = $\frac{1}{8}$ inch. Ans.

2. ALPHŒUS.—Simplify

$$\left(\frac{3a^2 - b^2}{4a^2 - b^2} + \frac{2a - b}{2a + b}\right) \div \frac{a - \frac{4b}{7}}{2a + b}.$$

(*Certificate*, 1886.)

$$\left(\frac{3a^2 - b^2}{4a^2 - b^2} + \frac{2a - b}{2a - b}\right) \div \frac{a - \frac{4b}{7}}{a + b}$$

$$= \frac{3a^2 - b^2 + (2a - b)^2}{(2a + b)(2a - b)} \div \frac{7a - 4b}{7(2a + b)}$$

$$= \frac{3a^2 - b^2 + 4a^2 - 4ab + b^2}{(2a + b)(2a - b)} \times \frac{7(2a + b)}{7a - 4b}$$

$$= \frac{7a^2 - 4ab}{2a - b} \times \frac{7}{7a - 4b}$$

$$= \frac{a(7a - 4b)}{2a - b} \times \frac{7}{7a - 4b}$$

$$= \frac{7a}{2a - b}. \quad \text{Ans.}$$

3. HERBERTUS.—If $(x - a)y = (x - a)z$, does it follow that $y = z$?

When is this conclusion incorrect? Explain the reason carefully. (*Naval Cadet Exam. Papers, June*, 1889.)

If x is a surd, where the power is even, it may have two roots opposite in sign.

Let $x = \sqrt{7}$; then it may be either $\sqrt{7}$ or $-\sqrt{7}$.

If $(x - a)y = (x - a)z$, we might have

$$(\sqrt{7} - a)y = (-\sqrt{7} - a)z,$$

and therefore y would not be equal to z.

If we take the positive or negative sign of the root for *both*,

$$(\sqrt{7} - a)y = (\sqrt{7} - a)z,$$

we should then have $y = z$.

4. PYTHAGORAS.—The national debt of a country was increased by one-fourth in a time of war. During a long peace which followed £25,000,000 was paid off, and at the end of that time the rate of interest was reduced from 4½ per cent. to 4 per cent. It was then found that the amount of annual interest was the same as before the war. What was the amount of debt before the war? (*Todhunter.*)

Let x = debt before war in pounds,

Then $\frac{5x}{4}$ = debt after war in pounds;

$$\therefore x \times \frac{4\frac{1}{2}}{100} = \left(\frac{5x}{4} - 25{,}000{,}000\right) \times \frac{4}{100}$$

$$\frac{9x}{2} = 5x - 100{,}000{,}000$$

$$100{,}000{,}000 = 5x - \frac{9x}{2}$$

$$= \frac{x}{2}$$

$\therefore x = 200{,}000{,}000$.

$\therefore$ Debt before the war = £200,000,000. Ans.

5. J. TOVEY.—Solve:—

$$\left.\begin{aligned} x^2 + xy &= 15 \\ x^2 - y^2 &= 21 \end{aligned}\right\}$$

$$\left.\begin{aligned} (1)\ x(x + y) &= 15 \\ (2)\ (x + y)(x - y) &= 21 \end{aligned}\right\}$$

$$\frac{x(x + y)}{(x + y)(x - y)} = \frac{15}{21}$$

$$\frac{x}{x - y} = \frac{5}{7}$$

$$7x = 5x - 5y$$

$$2x = -5y$$

$$\therefore y = -\frac{2x}{5}.$$

$$(1)\ x^2 + xy = 15$$

$$x^2 + \left(-\frac{2x}{5} \times x\right) = 15$$

$$x^2 - \frac{2x^2}{5} = 15$$

$$5x^2 - 2x^2 = 75$$

$$3x^2 = 75$$

$$x^2 = 25$$

$$\therefore x = \pm 5.$$

$$y = -\frac{2x}{5}$$

$$= \pm 5 \times -\frac{2}{5}$$

$$= \mp 2.$$

$\therefore x = \pm 5$ and $y = \mp 2$.

6. AULD REEKIE.—An officer can form the men of his regiment into a hollow square 12 deep. The number of men in the regiment is 1,296. Find the number of men in the front of the hollow square.

(*Todhunter's* 'Algebra for Beginners.')

Let x = No. of men in the front of the square,

Then $x^2 - [x - (12 \times 2)]^2 = 1{,}296$
$x^2 - (x - 24)^2 = 1{,}296$
$x^2 - (x^2 - 48x + 576) = 1{,}296$
$x^2 - x^2 + 48x - 576 = 1{,}296$
$48x = 1{,}296 + 576$
$= 1{,}872$
$\therefore x = 39$.

$\therefore$ No. of men in the front of the square = 39. Ans.

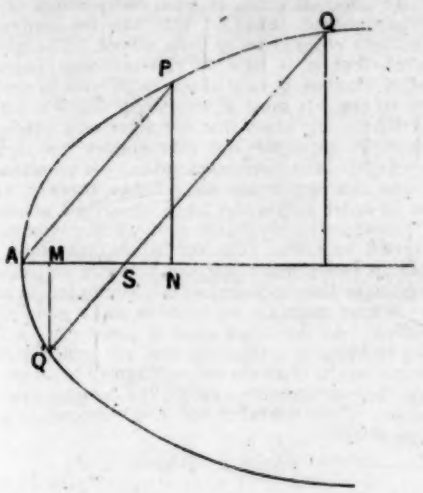
General.

1. F. JÔSEN.—1. No. 2. Lock's. 3. Poole, Bookseller's-row.

2. H. M.—Have you seen the Syllabus. Refer to this magazine for January. You have them all to prepare but only as there directed. Write again if you have any difficulty.

3. W. R.—QSQ¹ is a focal chord of a parabola parallel to AP; PN, QM, Q¹M¹ are the ordinates of P, Q, and Q¹. Prove that $SM^2 = AM \cdot AN$, and that $MM^1 = AP$.

(*Drew's* 'Conic Sections.')



Let the co-ordinates of Q, Q^1, P be respectively $x_1\ y_1$, $x_2\ y_2$, $x_3\ y_3$. Also let AS = a, and angle QSM = α.

(1) Since $QM^2 = 4AS \cdot AM$ (Prop. ix., page 11)

$$= 4a\ AM$$

$$\therefore AM = \frac{QM^2}{4a}$$

$$= \frac{y_1^2}{4a}.$$

$$PN^2 = 4a\ AN$$

$$y_3^2 = 4ax^3$$

$$y_3 = \frac{4ax^3}{y^3}$$

$$= 4a \cot PAN$$

$$= 4a \cot \alpha.$$

$$1 : 4a \cot \alpha = 1 : y_3,$$

$$y_1^2 : 4ay_1 \cot \alpha = y_1 : y_3,$$

$$\frac{y_1^2}{4a} : y_1 \cot \alpha = y_1 \cot \alpha : y_3 \cot \alpha,$$

$$AM : SM = SM : AN,$$

$$\therefore SM^2 = AM \cdot AN.$$

Q. E. D.

(2) The equation to QSQ^1 is

$$\frac{y - y_1}{y_1 - y_2} = \frac{x - x_1}{x_1 - x_2};$$

but $(y_1 - y_2)(y_1 + y_2) = 4a(x_1 - x_2)$,

Multiplying

$$(y - y_1)(y_1 + y_2) = 4a(x - x_1)$$

$$yy_1 - y_1^2 + yy_2 - y_1y_2 = 4ax - 4ax_1,$$

$$y(y_1 + y_2) = y_1y_2 + 4ax,$$

$$(\text{as } y_1^2 = 4ax_1)$$

But this line passes through a, O,

$$\therefore y_1y_2 = -4a^2.$$

Equation to AP is

$$\frac{y}{y_2} = \frac{x}{x_2},$$

$$\therefore y = \frac{y_2}{x_2}x$$

$$= \frac{y_3}{x_3}x.$$

Since AP is parallel to QQ^1

$$\therefore 4ax_3 = (y_1 + y_2)y_3,$$

$$y_3^2 = (y_1 + y_2)y_3,$$

$$y_3 = y_1 + y_2.$$

Since $y_1 + y_2 = y_3$,

$$\left.\begin{aligned} y_1^2 + 2y_1y_2 + y_2^2 &= y_3^2 \\ 4y_1y_2 &= -16a^2 \end{aligned}\right\}$$

$$y_1 - y_2 = \sqrt{y_3^2 + 16a^2}$$

$$= \sqrt{4ax_3 + 16a^2}.$$

Now $AP = \sqrt{y_3^2 + x_3^2}$,

And $MM^1 = AM - AM^1$

$$= \frac{1}{4a}(y_1^2 - y_2^2)$$

$$= \frac{1}{4a}(y_1 - y_2)(y_1 + y_2)$$

$$= \frac{1}{4a}\sqrt{4ax_3 + 16a^2} \times \sqrt{4ax_3}$$

$$= \sqrt{x_3^2 + 4ax_3}$$

$$= \sqrt{x_3^2 + y_3^2}.$$

$$\therefore MM^1 = AP.$$

Q. E. D.

How to Teach School Children to Sing from the Staff Notation.

BY W. G. McNAUGHT,

Associate of The Royal Academy of Music.

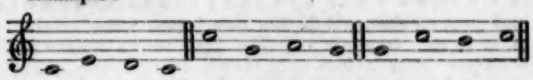
51. The foregoing exercises go beyond the sight singing requirements of the code. They serve at least to show in what direction the class should travel. It may be rarely possible to get so far with Standard II. The discretion of the teacher must decide how much or how little should be introduced. In order to explain, however cursorily, the notation of the school songs used, it may be necessary to introduce the time signature $\frac{3}{4}$, the application of the dot to minims and crotchets and the signs for the most used rests. Suggestions as to the manner of teaching these facts will be found in the lessons for Div. III.; see also section 55.

DIVISION II.—EAR TEST.

CODE REQUIREMENT.

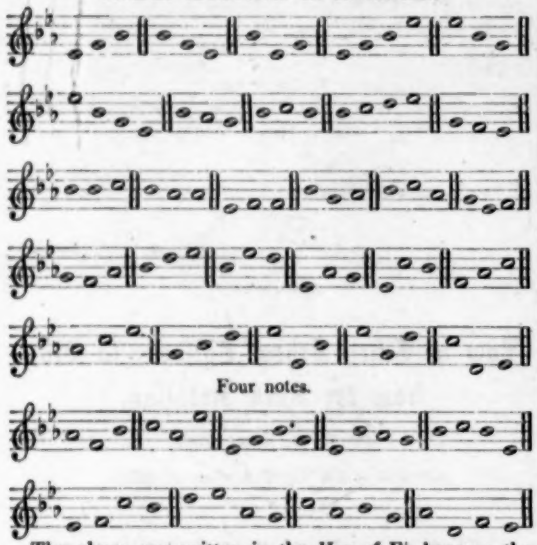
To repeat (i.e., imitate, not name) a simple phrase of not more than four notes, using the syllable 'laa,' after hearing the Examiner sing (or play) it twice through.

Example :



52. The ear tests for this division are comparatively slight. To some, it may appear that mere imitation exercises are of no value whatever in a note-singing course. But as a matter of fact, such exercises are extremely useful in awakening the ear. They should be used abundantly in classes where there is not much natural capacity. Even in dealing with advanced pupils in the higher courses, the capacity of the ear can be most severely tested by imitation exercises. Conductors know that in choosing voices for a choir, the singer who can imitate fluently but cannot read freely, is likely to be quite as useful as the singer who can read but cannot imitate freely.

53. Begin by giving single notes, then give fragments of the Doh chord and add little stepwise phrases, commencing with some tone of the doh chord. Give some exercises that go (1) straight up, (2) straight down, (3) up and down or *vice versa* (4) and some that strike the same tone twice in succession. Do not allow a slide to be made to single tones or to the first tone of a phrase. Give the pattern in the best manner possible. As skill advances vary the form of exercise; for instance, sing two phrases and require the first only to be imitated. Get pupils to invent phrases for the others to imitate. The following are

GRADED EXERCISES IN IMITATION.

Four notes.

The above are written in the Key of E♭ because the range from doh to doh^1 in this key is easy.

54. The naming of tones by ear should be commenced in Div. II. No notation is called for at this stage. The children answer in sol-fa names. Begin by giving various arrangements of doh, me, soh. Make the exercises very easy at first. State that you are going to sing **d m s** or **d s m — s m d** or **s d m — m d s** or **m s d**. Then say only where you will begin, and leave the class to think out the alternatives. Next, promising to keep to the same three tones, do not announce where you will begin. Add the higher **doh** and work in a similar manner. When introducing the other scale tones (**ray, fah, lah, te**), show by examples their expectant and other peculiar effects. Adopt the plan of giving alternatives as described above. For instance, ask whether you sing **s l s** or **s f m — s t d^1** or **s l s — m r d** or **m r m — d r m** or **d r d**. Then promise to begin on some named tone and ask the class to find out what you sing round about it. Say beginning upon *soh*, sing—**|s f m s||s f f m||s l t d^1||**
|s f m r||s l l s||s s l s||s s l t||s l t t||s f m m||
and treat **me, doh,** and higher **doh** in the same manner. It is a too common mistake to give no other ear exercises than a few very much beyond the ability of the majority of the class. The proper course is to give a great number of exercises quite within the average ability of the children and only a few more difficult exercises to encourage the sharper pupils.

DIVISION II.—SONG TEST.

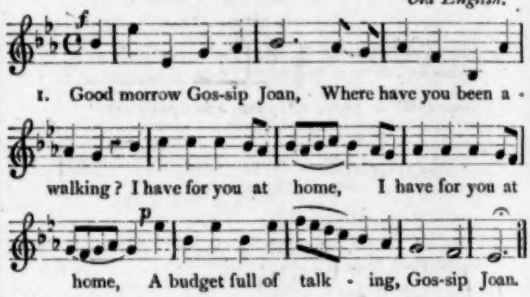
CODE REQUIREMENT.

To sing in unison in good time and tune, and sweetly, a school song (set to words) previously prepared.

55. Five songs have to be presented at the inspection. These may be learnt by ear or by note and may be sung with or without book. In this division, at least, the songs should be simple and pleasing, and thoroughly adapted to the age of the children. It is much the best to choose music the effect of which is quite independent of parts or accompaniment—melodies that can be hummed or whistled and enjoyed away from school. The question arises, whether it is wise to choose songs containing musical difficulties beyond those dealt with in the note-singing course. It must be confessed, that it is not easy to find interesting tunes that are rigorously confined to the tones of one scale and that employ no rhythmic forms beyond those mentioned in the code requirements. It is true that numerous song books contain 'tunes' written to order within the limits described above, but these 'tunes' are nearly always simply dull, commonplace, unmitigated exercises. On the whole, therefore, it is best not to reject tunes that are perfectly singable and pretty because they include points not fully taught at this stage. A brief dogmatic explanation and a good pattern will suffice. At the same time if tunes can be found that are thoroughly interesting and yet perfectly simple in construction, it is an obvious advantage to adopt them because they so strongly enforce the lessons that have been given. The following old English song is a very good specimen.

GOSSIP JOAN.

Old English.


1. Good morrow Gos-sip Joan, Where have you been a -
walking? I have for you at home, I have for you at
home, A budget full of talk - ing, Gos-sip Joan.

2. My sparrow's flown away,
And will no more come to me;
‖: I've broke a glass to-day :‖
The price will quite undo me, Gossip Joan!

3. I've lost a Harry groat,
Was left me by my granny;
‖: I cannot find it out :‖
I've searched in ev'ry cranny, Gossip Joan!

4. I've lost my wedding ring,
That was made of silver gilded;
‖: I'd drink would please a king :‖
But that my cat has spill'd it, Gossip Joan!

5. My pocket is cut off,
That was full of sugar candy;
‖: I cannot stop my cough :‖
Without some cherry brandy, Gossip Joan!

(To be continued.)

Certificate Examination, 1889.

Male Candidates.

FIRST YEAR.

Algebra and Mensuration.

(THREE *hours allowed for this paper.*)

Candidates are not permitted to answer more than NINE questions in Algebra, and TWO questions in Mensuration.

The solution must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Algebra.

1. Resolve into elementary factors—
(1) $x^2 - 3x - 130$.
(2) $x^4 - 81$.
(3) $a^2(b - c) + b^2(c - a) + c^2(a - b)$.

(1) $x^2 - 3x - 130$
$= (x + 10)(x - 13)$. Ans.

(2) $x^4 - 81$
$= (x^2 - 9)(x^2 + 9)$
$= (x + 3)(x - 3)(x^2 + 9)$. Ans.

(3) $a^2(b - c) + b^2(c - a) + c^2(a - b)$
$= a^2b - a^2c + b^2c - ab^2 + c^2(a - b)$
$= a^2(a - b) - c(a^2 - b^2) + c^2(a - b)$
$= (a - b)\{a^2 - c(a + b) + c^2\}$
$= (a - b)\{c^2 - c(a + b) + ab\}$
$= (a - b)(c - a)(c - b)$ Ans.

2. Prove the rule for finding the greatest common measure of two algebraical expressions, and find the least common multiple of—

$x^2 - 3x + 2$,
$x^2 - 5x + 6$,
and $x^2 - 7x + 12$.

The proof of the rule for finding the G.C.M. is given in most Algebras.

$(x^2 - 3x + 2) = (x - 1)(x - 2)$,
$(x^2 - 5x + 6) = (x - 2)(x - 3)$,
$(x^2 - 7x + 12) = (x - 3)(x - 4)$,
$\therefore$ L.C.M. $= (x - 1)(x - 2)(x - 3)(x - 4)$
$= (x^2 - 3x + 2)(x^2 - 7x + 12)$
$= x^4 - 10x^3 + 35x^2 - 50x + 24$. Ans.

3. Many pupil teachers, when asked to prove a formula, simply give a numerical illustration. Explain why this is worthless.

Prove that a multiplied by b is equal to b multiplied by a, where a and b are *any* positive integers.

If we take the formula

$$(a + b)(a - b) = a^2 - b^2,$$

and substitute 5 and 3 for a and b respectively, we obtain

$$(5 + 3)(5 - 3) = 8 \times 2 = 16,$$
$$(5^2 - 3^2) = 25 - 9 = 16;$$

We show by this numerical illustration that the formula is true for the numbers given, but it does not prove that it is true for *all* numbers, or that it is true generally, and therefore the illustration is worthless.

$a \times b$ means $1 + 1 + 1 \ldots\ldots a$ terms,
$1 + 1 + 1 \ldots\ldots a$ terms,.....
when there are $1 + 1 + 1 \ldots\ldots b$ terms of lines;
But $b \times a$ means $1 + 1 + 1 \ldots\ldots b$ terms,
$1 + 1 + 1 \ldots\ldots b$ terms,.....
when there are $1 + 1 + 1 \ldots\ldots a$ terms of lines;
But the units in are the same in both cases,
$\therefore a \times b = b \times a$.

4. Find the square root of

$$x^6 - 8x^5 + 24x^4 - 34x^3 + 24x^2 - 8x + 1.$$

What must be the value of a in order that

$$x^4 + 2x^3 + 5x^2 + 4x + a$$

may be a perfect square?

$x^6 - 8x^5 + 24x^4 - 34x^3 + 24x^2 - 8x + 1 \mid x^3 - 4x^2 + 4x - 1$

x^6
$2x^3 - 4x^2 \mid -8x^5 + 24x^4$
$-8x^5 + 16x^4$
$2x^3 - 8x^2 + 4x \mid 8x^4 - 34x^3 + 24x^2$
$8x^4 - 32x^3 + 16x^2$
$2x^3 - 8x^2 + 8x - 1 \mid -2x^3 + 8x^2 - 8x + 1$
$-2x^3 + 8x^2 - 8x + 1$

$\therefore$ Square root $= x^3 - 4x^2 + 4x - 1$. Ans.

$x^4 + 2x^3 + 5x^2 + 4x + a \mid x^2 + x + 2$

x^4
$2x^2 + x \mid 2x^3 + 5x^2$
$2x^3 + x^2$
$2x^2 + 2x + 2 \mid 4x^2 + 4x + a$
$4x^2 + 4x + 4$

$\therefore a = 4$. Ans.

5. Solve the equations—

(1) $\frac{4x - 3}{2} - \frac{5x - 4}{3} = \frac{6x - 5}{4} - 1\frac{1}{12}$.

(2) $(x - 3)(x - 4)(x + 12) = x^3$.

(3) $\begin{cases} x + y = 8, \\ 15x^2 - 34xy + 15y^2 = 0. \end{cases}$

(1) $\frac{4x - 3}{2} - \frac{5x - 4}{3} = \frac{6x - 5}{4} - 1\frac{1}{12}$
$24x - 18 - 20x + 16 = 18x - 15 - 1$
$24x - 20x - 18x = -16 - 16 + 18$
$-14x = -14$
$\therefore x = 1$.

(2) $(x - 3)(x - 4)(x + 12) = x^3$
$(x^2 - 7x + 12)(x + 12) = x^3$
$x^3 + 5x^2 - 72x + 144 = x^3$
$5x^2 - 72x = -144$
$x^2 - \frac{72x}{5} + (\frac{36}{5})^2 = 12\frac{96}{25} - 28\frac{4}{5}$
$= \frac{324}{25}$
$x - \frac{36}{5} = \pm \frac{18}{5}$
$\therefore x = \pm \frac{18}{5} + \frac{36}{5}$
$= 12$, or $\frac{18}{5}$.

(3) (1) $x + y = 8$
(2) $15x^2 - 34xy + 15y^2 = 0$
(1) $x^2 + 2xy + y^2 = 64$
$15x^2 + 30xy + 15y^2 = 960$
(2) $15x^2 - 34xy + 15y^2 = 0$
$64xy = 960$
$4xy = 60$
(1) $x^2 + 2xy + y^2 = 64$
$4xy = 60$
$x^2 - 2xy + y^2 = 4$
$\therefore x - y = \pm 2$
$x + y = 8$
$2x = 10$ or 6
$2y = 6$ or 10
$\therefore x = 5$ or 3
$y = 3$ or 5

6. Prove that the square of the sum of any two numbers + the square of their difference = twice the sum of the squares of the numbers.

Also that the sum of the cubes of three even numbers in arithmetical progression is divisible by 24.

$(a + b)^3 + (a - b)^3$
$= a^3 + 2ab + b^3 + a^3 - 2ab + b^3$
$= 2a^3 + 2b^3$
$= 2(a^3 + b^3)$.

Let a, $a + d$, and $a + 2d$ be three even numbers in arithmetical progression.

$a^3 + (a + d)^3 + (a + 2d)^3$
$= a^3 + a^3 + 3a^2d + 3ad^2 + d^3 + a^3 + 6a^2d + 12ad^2 + 8d^3$
$= 3a^3 + 9a^2d + 15ad^2 + 9d^3$
$= 3(a^3 + 3a^2d + 5ad^2 + 3d^3)$,

As both a and d are even, each of the terms within the brackets is divisible by 2^3 or 8,

$\therefore$ Sum of cubes is divisible by 3×8 or 24.

7. Simplify—

$$\frac{ab(a - b) - a(a - 1) + b(b - 1)}{(a - b)(a - 1)(b - 1)},$$

and find the value of

$$(x^2 + xy + y^2)(x^2 - xy + y^2),$$

when $x = 2^{\frac{1}{3}}$ and $y = 3^{\frac{1}{3}}$.

$$\frac{ab(a - b) - a(a - 1) + b(b - 1)}{(a - b)(a - 1)(b - 1)}$$
$$= \frac{ab(a - b) - a^2 + a + b^2 - b}{(a - b)(a - 1)(b - 1)}$$
$$= \frac{ab(a - b) + (a - b) - (a^2 - b^2)}{(a - b)(a - 1)(b - 1)}$$
$$= \frac{ab + 1 - (a + b)}{(a - 1)(b - 1)}$$
$$= \frac{ab - (a + b) + 1}{(a - 1)(b - 1)}$$
$$= \frac{(a - 1)(b - 1)}{(a - 1)(b - 1)}$$
$$= 1.$$ Ans.

$$(x^2 + xy + y^2)(x^2 - xy + y^2)$$
$$= \{(x^2 + y^2) + xy\}\{(x^2 + y^2) - xy\}$$
$$= (x^2 + y^2)^2 - (xy)^2$$
$$= x^4 + 2x^2y^2 + y^4 - x^2y^2$$
$$= x^4 + x^2y^2 + y^4$$
$$= (2^1)^4 + (2^1)^2(3^1)^2 + (3^1)^4$$
$$= 2^2 + (2 \times 3) + 3^2$$
$$= 4 + 6 + 9$$
$$= \underline{19}. \text{ Ans.}$$

Second method—

$$(x^2 + xy + y^2)(x^2 - xy + y^2)$$
$$= (2 + \sqrt{6} + 3)(2 - \sqrt{6} + 3)$$
$$= (5 + \sqrt{6})(5 - \sqrt{6})$$
$$= 25 - 6$$
$$= \underline{19}. \text{ Ans.}$$

8. A bag contains sovereigns and shillings. If the number of sovereigns is doubled, the contents of the bag will be worth £21; but if the number of shillings is doubled, the contents will be worth only £12. Find how many coins of each kind are in the bag.

Let x = number of sovereigns,
and let y = ,, shillings;

Then (1) $(2x \times 20) + y = 21 \times 20$
(2) $(x \times 20) + 2y = 12 \times 20$

(1) $40x + y = 420$
(2) $20x + 2y = 240$
(1) $80x + 2y = 840$
(2) $20x + 2y = 240$

$60x = 600$
$\therefore x = 10.$

(1) $40x + y = 420$
$\therefore y = 420 - 400$
$= \underline{20}.$

$\therefore$ Number of sovereigns = 10
,, shillings = 20 } Ans.

9. Prove that a ratio of greater inequality is diminished, and a ratio of less inequality is increased, by adding the same to both its terms.

If $a : b :: c : d$
then $$\frac{a^2 - ab + b^2}{(a-b)^2} = \frac{c^2 - cd + d^2}{(c-d)^2}.$$

Let the ratio be $\frac{a}{b}$, and let a new ratio be formed by adding x to both terms.

Then $\frac{a+x}{b+x}$ is greater or less than $\frac{a}{b}$, according as $\frac{b(a+x)}{b(b+x)}$ is greater or less than $\frac{a(b+x)}{b(b+x)}$;

that is, according as $b(a+x)$ is greater or less than $a(b+x)$;
that is, according as xb is greater or less than xa;
that is, according as b is greater or less than a.

If $a : b :: c : d$,

$$\frac{a}{b} = \frac{c}{d}$$
$$\frac{a^2}{b^2} = \frac{c^2}{d^2},$$
$$\frac{a^2 + b^2}{b^2} = \frac{c^2 + d^2}{d^2};$$
$$\frac{a}{b} = \frac{c}{d},$$
$$\frac{a+b}{b} = \frac{c+d}{d};$$
$$\therefore \frac{a^2 + b^2}{b^2} \times \frac{b}{a+b} = \frac{c^2 + d^2}{d^2} \times \frac{d}{c+d},$$
$$\frac{a^2 - ab + b^2}{b^2} = \frac{c^2 - cd + d^2}{d^2};$$
$$\frac{a}{b} = \frac{c}{d},$$
$$\frac{a-b}{b} = \frac{c-d}{d},$$
$$\frac{(a-b)^2}{b^2} = \frac{(c-d)^2}{d^2},$$
$$\frac{a^2 - ab + b^2}{b^2} \times \frac{b^2}{(a-b)^2} = \frac{c^2 - cd + d^2}{d^2} \times \frac{d^2}{(c-d)^2},$$
$$\therefore \frac{a^2 - ab + b^2}{(a-b)^2} = \frac{c^2 - cd + d^2}{(c-d)^2}.$$

10. The repeating part of a recurring decimal contains p figures. Show that the decimal is an infinite geometrical progression whose ratio is $\frac{1}{10^p}$, and prove the rule for converting a recurring decimal to a vulgar fraction.

Let the non-recurring part contain q figures, and the recurring part of the decimal contain p figures.

Let Q denote the figures that do not recur, and P the figures which do recur.

The terms after $\frac{Q}{10^q}$ constitute an infinite geometrical progression, of which the first term is $\frac{P}{10^{q+p}}$, and the common ratio is $\frac{1}{10^p}$.

Hence we may say that the sum of an infinite number of terms of this series

$$= \frac{P}{10^{q+p}} \div \left\{1 - \frac{1}{10^p}\right\}$$
$$= \frac{P}{10^{q+p}} \div \frac{10^p - 1}{10^p}$$
$$= \frac{P}{10^q(10^p - 1)};$$

$\therefore$ Value of the decimal $= \frac{Q}{10^q} + \frac{P}{10^q(10^p - 1)}$
$$= \frac{Q(10^p - 1) + P}{10^q(10^p - 1)}$$
$$= \frac{Q \cdot 10^p + P - Q}{10^q(10^p - 1)}$$
$$= \frac{\text{Decimal} - \text{Non-recurring part}}{p \text{ nines followed by } q \text{ ciphers}};$$

$\therefore$ Numerator = Decimal − Non-recurring part,
Denominator = As many nines as there are recurring figures followed by as many ciphers as there are non-recurring figures.

Mensuration.

$\pi = \frac{22}{7}$.

1. Find, to the nearest foot, the diameter of a circle whose area = half an acre.

Radius$^2 \times \frac{22}{7}$ = 2,420 sq. yds.

$$\text{Radius}^2 = \frac{2420 \times 7}{22} \text{ sq. yds.}$$
$$= 770 \text{ sq. yds.}$$
$$= 6{,}930 \text{ sq. ft.}$$
$$\text{Radius} = \sqrt{6930} \text{ sq. ft.}$$
$$= 83{\cdot}2 \ldots \text{ ft.}$$

$\therefore$ Diameter = $\underline{166 \text{ ft.}}$ Ans.

2. A circle and an equilateral triangle have equal perimeters; compare their areas.

Let perimeters = $3a$,
Then area of circle = radius$^2 \times \frac{22}{7}$
$$= \left(\frac{3a}{2 \times \frac{22}{7}}\right)^2 \times \frac{22}{7}$$
$$= \frac{9a^2}{4 \times \frac{22}{7}}$$
$$= \frac{63a^2}{88};$$

Area of equilateral triangle $= \frac{a^2\sqrt{3}}{4}$.

$\therefore$ Area of circle : Area of equilateral triangle
$$:: \frac{63a^2}{88} : \frac{a^2\sqrt{3}}{4},$$
$$:: 63 : 22\sqrt{3},$$
$$:: 63 : \sqrt{1452},$$
$$:: 63 : \underline{38{\cdot}1\ldots}$$

3. The floor of a square room is covered with carpet $\frac{3}{4}$ yard wide, at 3s. 4½d. per yard. The walls are painted at a cost of 2½d. per square foot. The carpet costs as much as the painting; the room is 12 feet high; find the dimensions of the floor.

3s. 4½d. × (Side in yards)² × ¾
= 2½d. × Side in yards × 3 × 4 × 12,
3s. 4½d. × Side in yards × ¾ = 2½d. × 12 × 12,
162 × Side in yards × ¾ = 9 × 12 × 12,

$$\text{Side in yards} = \frac{9 \times \overset{6}{\cancel{12}} \times \overset{3}{\cancel{12}} \times 3}{\underset{18}{\cancel{162}} \times 4};$$

$$\therefore \text{Side of room} = \underline{6 \text{ yards.}} \quad \text{Ans.}$$

Male Candidates.

SECOND YEAR.

Algebra and Mensuration.

THREE *hours allowed for this Paper.*

Candidates are not permitted to answer more than NINE questions in Algebra, and TWO in Mensuration.

Candidates who have not passed with credit in Arithmetic in one of the two immediately preceding years must answer THREE of the FOUR questions on Arithmetic, instead of those on Mensuration.

The *solution* must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

Algebra.

1. Prove that the sum of the squares of any number of unequal quantities is less than the square of their sum.

In an examination it was found that the aggregate marks of each candidate came to the same amount. The examiner then assigned to each the square of the marks originally gained by him for each subject; prove that if one candidate, and one only, was totally ignorant of every subject but one he would come out head of the list.

$(a + b + c + \ldots)^2$
$= a^2 + b^2 + c^2 + \ldots + 2ab + 2ac + 2bc + \ldots$
$\therefore a^2 + b^2 + c^2 + \ldots$ is less than $(a + b + c + \ldots)^2$.

Let x = aggregate number of marks,
and let $a, b, c, \ldots$ = number of marks for each subject,
Then $x = a + b + c + \ldots$
$x^2 = (a + b + c + \ldots)^2$,
But $(a + b + c + \ldots)^2$ is greater than $a^2 + b^2 + c^2 + \ldots$
$\therefore x^2$ is greater than $a^2 + b^2 + c^2 + \ldots$
Wherefore the one who answers only one subject will be the head of the list.

2. Prove that the sum of the roots of the equation $x^2 + px + q = 0$ is equal to $-p$,
and the product $= q$.

Form the equation of which the roots are $mu + nv$, $mv + nu$, where u and v are the roots of the equation $x^2 + x + 1 = 0$.

$$x^2 + px + q = 0$$
$$x^2 + px + \left(\frac{p}{2}\right)^2 = \frac{p^2}{4} - q$$
$$= \frac{p^2 - 4q}{4}$$
$$x + \frac{p}{2} = \frac{\pm\sqrt{p^2 - 4q}}{2}$$
$$\therefore x = \frac{-p \pm \sqrt{p^2 - 4q}}{2}.$$

$$\text{Sum of roots} = \frac{-p + \sqrt{p^2 - 4q}}{2} + \frac{-p - \sqrt{p^2 - 4q}}{2}$$
$$= \frac{-2p}{2}$$
$$= -p.$$

$$\text{Product of roots} = \frac{-p + \sqrt{p^2 - 4q}}{2} \times \frac{-p - \sqrt{p^2 - 4q}}{2}$$
$$= \frac{p^2 - (p^2 - 4q)}{4}$$
$$= \frac{4q}{4}$$
$$= q.$$

Roots of the equation
$x^2 + x + 1 = 0$
are $\frac{-1 \pm \sqrt{-3}}{2}$.

$\therefore$ Roots of required equation are :—

$$\frac{m(-1 + \sqrt{-3})}{2} + \frac{n(-1 - \sqrt{-3})}{2}$$

and $\frac{m(-1 - \sqrt{-3})}{2} + \frac{n(-1 + \sqrt{-3})}{2}$

$= \frac{-(m+n) + \sqrt{-3}(m-n)}{2}$ and

$\frac{-(m+n) - \sqrt{-3}(m-n)}{2}$;

$\therefore$ Equation is :—

$$\left\{x - \frac{-(m+n) + \sqrt{-3}(m-n)}{2}\right\} \times$$
$$\left\{x - \frac{-(m+n) - \sqrt{-3}(m-n)}{2}\right\} = 0$$
$$\left\{2x + (m+n) - \sqrt{-3}(m-n)\right\} \times$$
$$\left\{2x + (m+n) + \sqrt{-3}(m-n)\right\} = 0$$
$$\left\{2x + (m+n)\right\}^2 - \left\{\sqrt{-3}(m-n)\right\}^2 = 0$$
$$4x^2 + 4x(m+n) + (m+n)^2 - \left\{-3(m-n)^2\right\} = 0$$
$$4x^2 + 4x(m+n) + m^2 + 2mn + n^2 + 3m^2 - 6mn + 3n^2 = 0$$
$$4x^2 + 4x(m+n) + 4m^2 - 4mn + 4n^2 = 0.$$
$$\therefore x^2 + x(m+n) + m^2 - mn + n^2 = 0.$$

3. Solve the equations :

(1) $\sqrt[3]{x} + \sqrt[3]{x} + 1 = 1$.

(2) $\left.\begin{aligned} x - y &= m \\ nx + my + y^2 &= 0. \end{aligned}\right\}$

(1) $x^{\frac{1}{3}} + (x+1)^{\frac{1}{3}} = 1$
$(x+1)^{\frac{1}{3}} = 1 - x^{\frac{1}{3}}$

Cubing each side] $x + 1 = 1 - 3x^{\frac{1}{3}} + 3x^{\frac{2}{3}} - x$
$2x - 3x^{\frac{2}{3}} = -3x^{\frac{1}{3}}$

Dividing by $x^{\frac{1}{3}}$] $2x^{\frac{2}{3}} - 3x^{\frac{1}{3}} = -3$
$x^{\frac{2}{3}} - \frac{3}{2}x^{\frac{1}{3}} = -\frac{3}{2}$

Completing the square] $x^{\frac{2}{3}} - \frac{3}{2}x^{\frac{1}{3}} + (\frac{3}{4})^2 = \frac{9}{16} - \frac{24}{16}$
$= -\frac{15}{16}$

Extracting square root] $x^{\frac{1}{3}} - \frac{3}{4} = \frac{\pm\sqrt{-15}}{4}$
$x^{\frac{1}{3}} = \frac{3 \pm \sqrt{-15}}{4}$
$\therefore x = \left(\frac{3 \pm \sqrt{-15}}{4}\right)^3$.

(2) $\left.\begin{aligned} x - y &= m \\ nx + my + y^2 &= 0 \end{aligned}\right\}$
$x = m + y$.
$\therefore n(m+y) + my + y^2 = 0$
$y^2 + (m+n)y = -mn$
$y^2 + (m+n)y + \left(\frac{m+n}{2}\right)^2 = \frac{(m+n)^2}{4} - mn$
$= \frac{(m-n)^2}{4}$
$y + \frac{m+n}{2} = \pm\frac{m-n}{2}$
$\therefore y = \frac{\pm(m-n) - (m+n)}{2}$
$= -m$ or $-n$.
$x = m - y$
$\therefore x = m - m$ or $m - n$
$= 0$ or $m - n$.
$\therefore x = 0$ and $y = -m$,
or $x = m - n$ and $y = -n$.

4. For 3s. two yards more of cheap calico can be bought than of better quality, and 10 yards of the latter cost 6d. more than 12 yards of the former; find the price per yard of each quality.

Let x = price per yard of cheap quality in shillings,

Then $x + \frac{1}{2}$ = price per yard of better quality in shillings;

$\therefore 10(x + \frac{1}{2}) - 12x = \frac{1}{2}$

$10x + 15 - 12x = \frac{1}{2}$

$-2x = -14\frac{1}{2}$

$\therefore x = 7\frac{1}{4}$.

$\therefore$ Price of cheap quality = 7¼s. or 7s. 3d.

,, better ,, = 7s. 3d. + 1s. 6d. or 8s. 9d.

5. Define arithmetic and harmonic progression.

If $a + b$, $c + a$, $b + c$, be in H.P. then a^2, b^2, c^2 are in A.P.

Definitions can be obtained from any Algebra.

If $a + b$, $c + a$, $b + c$ be in H.P.,

Then $\frac{1}{b+c} - \frac{1}{a+c} = \frac{1}{a+c} - \frac{1}{a+b}$

$\frac{a+c-b-c}{(a+c)(b+c)} = \frac{a+b-a-c}{(a+b)(a+c)}$

$\frac{a-b}{(a+c)(b+c)} = \frac{b-c}{(a+b)(a+c)}$

$(a-b)(a+b) = (b-c)(b+c)$

$a^2 - b^2 = b^2 - c^2$;

$\therefore a^2$, b^2, c^2 are in A.P.

6. Having the number of combinations of n things taken r together, find the number taken $r + 1$ together.

In a company of 80 soldiers 5 are detailed daily for fatigue duty; how many different selections can be made, and on how many occasions will a given soldier escape duty?

Proof from book.

Number of selections $= \frac{80 \cdot 79 \cdot 78 \cdot 77 \cdot 76}{\lfloor 5}$

$= 2 \times 79 \times 26 \times 77 \times 76$

$= \underline{24,040,016}$. Ans.

If a given soldier escape duty, the number of times will be the number of combinations of 79 soldiers taken 5 at a time

$= \frac{79 \cdot 78 \cdot 77 \cdot 76 \cdot 75}{\lfloor 5}$

$= 24,040,016 \times \frac{15}{16}$ or $\frac{15}{16}$

$= \underline{22,537,515}$. Ans.

7. Find the greatest term in the expansion of $(1 + x)^n$ when n is a positive integer.

Find the co-efficient of the term involving $x^n y^n$ in the expansion of $(1 + x + y + xy)^{2n}$.

(Resolve the expression within brackets into factors.)

The first part is book work.

$(1 + x + y + xy)^{2n}$

$= \{(1 + x) + y(1 + x)\}^{2n}$

$= \{(1 + x)(1 + y)\}^{2n}$;

$\therefore$ Co-efficient of $x^n y^n$ = co-efficient of x^n in the expansion of $(1 + x)^{2n}$ × co-efficient of y^n in the expansion of $(1 + y)^{2n}$.

Now these terms are the middle terms of the expansions.

$\therefore$ Co-efficient of $x^n y^n$

$= \frac{\lfloor 2n}{\lfloor n \lfloor n} x^n \times \frac{\lfloor 2n}{\lfloor n \lfloor n} y^n$

$= \frac{(\lfloor 2n)^2}{(\lfloor n)^4} x^n y^n$.

8. A contractor employs two gangs of workmen equal in number, but a workman of one gang does as much in four days as a workman of the other in five. The wages of the superior workman are 28s., of the inferior 21s. per week. The contractor finds that if he employs both gangs on a piece of work he will spend £175 more, but finish the work in 25 weeks less than if he employed the inferior gang. Find how many men he employed.

Let x = number of men in each gang,

Then $28x$ = weekly wages of superior gang in shillings,

And $21x$ = ,, ,, inferior ,, ,, ;

$\therefore (28x - 21x) \times 25 = 175 \times 20$

$7x = 7 \times 20$

$\therefore x = 20$.

$\therefore$ Number of men employed = 20 × 2

$= \underline{40}$. Ans.

9. Find the amount of £P in n years at 100r per cent. per annum compound interest.

Show that the advantage per £1 for a year of having interest paid m times a year is approximately $\frac{m-1}{2m} r^2$, r being a small fraction.

The first part is book work.

Let r denote the interest of one pound for a year.

$\therefore$ Advantage per £1 $= (1 + \frac{r}{m})^m - (1 + r)$

$= (1 + m \cdot \frac{r}{m} + \frac{m(m-1)}{2} \cdot \frac{r^2}{m^2} + \ldots) - (1 + r)$

$= (1 + r + \frac{(m-1)r^2}{2m} + \ldots) - (1 + r)$

$= \frac{m-1}{2m} r^2$ approximately.

10. Define logarithm, mantissa, characteristic.

Why are results obtained by the use of logarithms generally approximate only?

Prove that $\log c = \log^a b \times \log^b c$.

The logarithm of a number to a given base is the index of the power to which the base must be raised to be equal to the number.

The integral part of a logarithm is called the characteristic and the decimal part the mantissa.

As the logarithms of most numbers are only approximate the results must be approximate.

Let $x = \log_a b$, and $y = \log^b c$,

Then $b = a^x$ and $c = b^y$,

$\therefore c = b^y$

$= (a^x)^y$

$= a^{xy}$,

$\therefore xy = \log_a c$;

But $xy = \log_a b \times \log_b c$,

$\therefore \log_a c = \log_a b \times \log_b c$.

11. A and B start at the same time to walk, each at his own uniform rate, from his home to the home of the other and back. They meet first 6 miles from A's house and next 4 miles from B's. What is the distance from A's house to B's?

Let x = distance in miles,

Then A walks 6 miles while B walks $(x - 6)$ miles,

And A walks $(x + 4)$ miles while B walks $(2x - 4)$ miles;

$\therefore \frac{x+4}{2x-4} = \frac{6}{x-6}$

$x^2 - 2x - 24 = 12x - 24$

$x^2 = 14x$

$\therefore x = 14$.

$\therefore$ Distance from A's house to B's = 14 miles.

Mensuration.

($\pi = 3\frac{1}{7}$)

(For those candidates only who have passed with credit in Arithmetic in one of the two immediately preceding years.)

1. A sphere floats with ⅞ of its surface immersed; find what fraction of its volume is immersed.

In a sphere whose radius is r, surface $= 4\pi r^2$.

In a segment of a sphere whose radius is r, if h be the height of the segment,

$$\text{surface} = 2\pi hr.$$
$$\therefore 2\pi hr = \tfrac{3}{4} \text{ of } 4\pi r^2$$
$$2h = 3r$$
$$\therefore h = \frac{3r}{2}.$$

Volume of sphere $= \frac{4}{3}\pi r^3$.

Volume of segment of sphere $= \frac{\pi h^2}{6}(6r - 2h)$

$$= \frac{\pi \times \left(\frac{3r}{2}\right)^2}{6}\left\{6r - \left(\frac{3r}{2} \times 2\right)\right\}$$
$$= \frac{9\pi r^3}{24} \times 3r$$
$$= \frac{9\pi r^3}{8}.$$

$\therefore$ Fraction of volume immersed $= \frac{9\pi r^3}{8} \div \frac{4\pi r^3}{3}$

$= \frac{27}{32}$. Ans.

2. A solid cone and a hollow cone stand on equal bases and contain the same amount of material. The internal radius of the base of the hollow cone $= \frac{9}{10}$ of the external; find the ratio of the heights of the two cones.

Let r = radius of base of cones, and let x and y = heights of the two cones;

Then volume of first cone $= \frac{1}{3}\pi r^2 x$,

And volume of second cone $= \frac{1}{3}\pi\left[r^2 y - \left\{\left(\frac{9}{10r}\right)^2 \times \frac{9}{10}y\right\}\right]$;

$$\therefore \tfrac{1}{3}\pi r^2 x = \tfrac{1}{3}\pi y\,(r^2 - \tfrac{729}{1000}r^2)$$
$$x = y\,(1 - \tfrac{729}{1000})$$
$$\frac{x}{y} = \tfrac{271}{1000}.$$

$\therefore$ Height of first cone : height of second cone :: 271 : 1000.

3. The bottom of a symmetrical tank 6 feet deep is a rectangle 8 feet by 5; the top a rectangle 10 feet by 7; find how many gallons of water it contains. (A cubic foot of water $= 6\frac{1}{4}$ gals.)

If a^2 and b^2 be the areas of the two ends and h the perpendicular height,

Then volume $= \frac{h}{3}(a^2 + ab + b^2)$.

$\therefore$ Volume of tank $= \frac{6}{3}\left[(8 \times 5) + \sqrt{8 \times 5 \times 10 \times 7} + (10 \times 7)\right]$ cub. ft.

$= 2(40 + \sqrt{2800} + 70)$ cub. ft.

$= 2\,(110 + 52{\cdot}915\ldots)$ cub. ft.

$= 325{\cdot}83$ cub. ft.

$\therefore$ Tank will contain $(325{\cdot}83 \times 6\frac{1}{4})$ gals. $= 2{,}036\frac{1}{2}$ gals. nearly.

Arithmetic.

(For those candidates only who have *not* passed with credit in Arithmetic in one of the two immediately preceding years.)

1. Reduce to its simplest form—

$$\frac{3{\cdot}05}{{\cdot}04275} \times \frac{{\cdot}342}{4{\cdot}216} \times \frac{1{\cdot}5318}{{\cdot}27}.$$

$$\frac{3{\cdot}05}{{\cdot}04275} \times \frac{{\cdot}342}{4{\cdot}216} \times \frac{1{\cdot}5318}{{\cdot}27}$$

$= \left(3\tfrac{5}{16} \div \frac{42\frac{7}{8}}{1000}\right) \times \left(\tfrac{342}{999} + 4\tfrac{148}{999}\right) \times \left(\tfrac{15318}{10000} \div \tfrac{27}{100}\right)$

$= (3\tfrac{5}{16} \div \tfrac{343}{8000}) \times (\tfrac{342}{111} + 4\tfrac{148}{999}) \times (\tfrac{7659}{5000} \div \tfrac{9}{100})$

$= \frac{55}{16} \times \frac{8000}{343} \times \frac{38}{111} \times \frac{29}{69} \times \frac{8519}{7659} \times \frac{100}{9}$

$= 160$. Ans.

2. Find the cube root of $1277289\frac{1}{8}$.

$1277289\frac{1}{8} = 108\frac{1}{2}$;

10'218'313(217

8

$2^2 \times 300 =$	1200	2218
$2 \times 1 \times 30 =$	60	
$1^2 =$	1	
	1261	1261
$21^2 \times 300 =$	132300	957313
$21 \times 7 \times 30 =$	4410	
$7^2 =$	49	
	136759	957313

$\therefore$ Cube root $= 21\frac{1}{2}$

$= 108\frac{1}{2}$. Ans.

3. A tradesman, who professed to sell his goods at 25 per cent. under cost price, explained that what he called cost price was in reality 30 per cent. above it, and that he expected to clear 5 per cent. profit. Find (1) what percentage he really gained or lost, (2) what was the amount of gain or loss on goods which he sold for £92 12s. 6d.?

(1) Suppose cost price were £100, then tradesman's price would be £130, and his selling price would be $\frac{3}{4}$ of £130 or £97½.

$\therefore$ His loss $=$ (£100 − £97½) per cent.

$= 2\frac{1}{2}$ per cent.

(2) £97½ : £92 12 6 :: 2½ : Loss.

2 2 2

195 5

£	s.	d.
39)92	12	6
£2	7	6.

Ans.

4. When the Two and-a-Half per Cents. are at 92½, and Two-and-Three-Quarter per Cents. at 97½, a person has a sum to invest which will produce £100 more of the former stock than of the latter. Find the difference in the income he can obtain by investing in either of the stocks. Neglect brokerage.

For an investment of £97½ in Two-and-Three-Quarter per Cents. £100 stock can be purchased.

£92½ : £97½ :: £100 : Amount of stock in Two-and-a-Half per Cents.

2 2

185 195

37 39

$= 105\frac{5}{37}$£.

Difference in stock $= £105\frac{5}{37} - £100$

$= £\frac{185}{37}$.

£ £ £

$\therefore \frac{185}{37}$: 100 :: 100 : Amount of second stock.

$= (37 \times 50)$£

$=$ £1,850.

$\therefore$ Amount of first stock $=$ £1,950.

Income in first stock $= 2\frac{1}{2}$ % on £1,950

$=$ £19 10s. × $2\frac{1}{2}$

$=$ £48 15s.;

Income in second stock $= 2\frac{3}{4}$ % on £1,850

$=$ £18 10s. × $2\frac{3}{4}$

$=$ £50 17s. 6d.;

$\therefore$ Difference in income $=$ £50 17s. 6d. − £48 15s.

$=$ £2 2s. 6d. Ans.

Male Candidates.

FIRST YEAR.

Euclid.

(THREE *hours allowed for this Paper.*)

Candidates are not allowed to answer more than EIGHT questions.

Capital letters (*excluding A, B, C, D, E, F*), not numbers, must be used in the diagrams.

All generally understood abbreviations and symbols for *words* may be used, but not symbols of *operation*, such as −, +, ×, PQ^2, PQ . RS.

1. Define *plane superficies, plane angle, semicircle, gnomon, angle of a segment, sector of a circle.*

If a triangle PQR be turned over about its side PQ, show by Prop. 4, Bk. I., that the line joining the two positions of R is perpendicular to PQ.

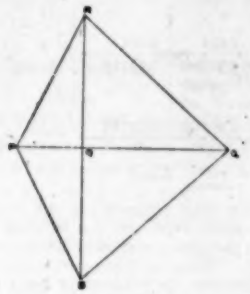


Fig. A.

Let the triangle PQR be turned over about the side PQ into the position PQS.

Join RS.

Then RS shall be perpendicular to PQ.

Proof.—Let RS cut PQ in O.

In triangles PRQ, PSQ,
side PR = side PS,
side RS is common,
and base QR = base QS,
$\therefore \angle RPQ = \angle SPQ$. (I., 8.)

Again in triangles PRO, PSO,
sides RP, PO = sides SP, PO,
and $\angle RPO = \angle SPO$,
$\therefore$ base RO = base SO,
and $\angle POR = \angle POS$; (I., 4.)

But these are adjacent angles,
$\therefore$ PO is at right angles to RS, (Def. 10.)
Wherefore RS is perpendicular to PQ.

Q. E. D.

2. To draw a straight line perpendicular to a given straight line of an unlimited length, from a given point without it.

From a given point draw a straight line, making equal angles with two given straight lines. (I., 26 may be employed.)

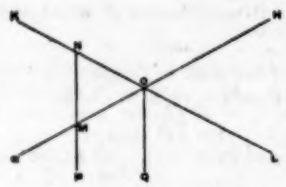


Fig. B.

Let the given straight lines GH, KL intersect in O, and let P be the given point.

Bisect the angle GOL by OQ, (I., 9.)

And through P draw PMN parallel to OQ (I. 31.), and cutting GH, KL in M, N.

Proof.— $\left.\begin{matrix}\angle NMO = \angle MOQ \\ \angle MNO = \angle LOQ\end{matrix}\right\}$ (I. 29.)
and $\angle MOQ = \angle LOQ$, (Con.)
$\therefore \angle NMO = \angle MNO$.

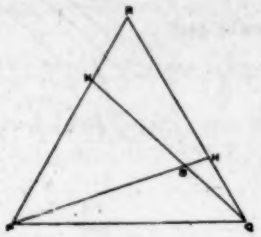
Q. E. F.

Notes.—(1) By bisecting angle HOL, and drawing a line through P parallel to this bisecting line, another line will be drawn making equal angles with GH, KL.

(2) If GH, KL are parallel, any line drawn through P will make equal angles with them.

3. All the exterior angles of any rectilineal figure, made by producing the sides successively in the same direction, are together equal to four right angles.

PQR is an equilateral triangle; H, K are points in QR, PR, such that QH = RK; QK, PH intersect at S. Show that the angle PSQ is equal to the sum of two angles of the equilateral triangle.

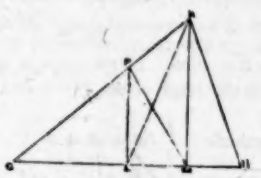


Proof.—In $\triangle$s KRQ, HQP,
sides KR, RQ = sides HQ, QP.
and $\angle KRQ = \angle HQP$,
$\therefore \angle RQK = \angle HPQ$. (I. 4.)
As $\angle HQS = \angle SPQ$,
$\therefore \angle SQP = \angle KPS$.
Now $\angle PSQ = \angle$s PKS, KPS. (I. 32.)
$= \angle$s KRQ, RQK, KPS
$= \angle$s PRQ, HQS, SQP
$= \angle$s PRQ, RQP
= two angles of the equilateral triangle.

Q.E.D.

4. Equal triangles upon the same base and upon the same side of it are between the same parallels.

Bisect a given triangle by a straight line drawn from a given point in one of its sides. (I. 37, 38.)



Let GHK be the given triangle, and P the given point in the side GK.

Bisect GH in L (I. 10), and join KL.

Join PL, and through K draw KM parallel to PL. (I. 31.)

Join PM. Then PM shall bisect the triangle GHK.

Proof.—$\triangle$ KPL = $\triangle$ PLM. (I. 37.)
Add $\triangle$ GPL to each of these,
$\therefore \triangle$ KGL = $\triangle$ PGM;
But $\triangle$ KGL = $\triangle$ KLH (I. 38),
or $\triangle$ KGL is half the triangle GHK,
$\therefore \triangle$ PGM is half the triangle GHK,
that is, PM bisects the triangle GHK. Q.E.F.

5. Show that Propositions 2 and 3 of the Second Book are special cases of Proposition 1. What are the corresponding algebraical formulæ for these three propositions?

In Prop. 2 we may consider two lines AB of equal length, and one of them divided into two parts in C. Then the rect. AB, AB or the square on AB is equal to the rectangles AB, AC and AB, BC. (II. 1.)

In Prop. 3 we may consider the two lines AB and BC, and AB divided into two parts in C.

Then the rect. AB, BC is equal to the rectangles BC, AC and BC, BC (II. 1), that is, the rectangle AC, CB and the square on BC.

Prop. 1.—Let the line BC contain a linear units, and the line A, b linear units.

Also suppose the parts BD, DE, EC to contain m, n, p, linear units respectively.

Then $a = m + n + p$,

Multiply these equals by b,

$\therefore ab = bm + bn + bp$.

Prop. 2. Let AB contain a linear units, and AC, CB, m and n linear units respectively.

Then $m + n = a$.

Multiply these equals by a,

$\therefore am + an = a^2$.

Prop. 3.—Let AB contain a linear units, and let BC contain m, and AC, n near units.

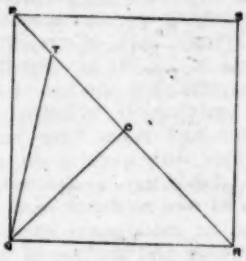
Then $a = m + n$,

Multiply these equals by m.

$\therefore am = m^2 + mn$.

6. If a straight line be divided into two equal and also into two unequal parts, the squares on the two unequal parts are together double of the square on half the line, and of the square on the line between the points of section.

In PR, a diagonal of the square PQRS, a point T is taken. Show that the triangle whose sides are equal to PT, TR, and the diagonal of a square described on QT, will be right-angled.



Bisect PR in O, and join OQ.

Squares on PT, TR = twice sq. on PO and twice sq. on TO (II. 9.)

= Twice sq. on OQ and twice sq. on TO,

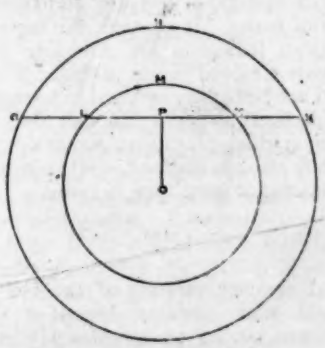
= Twice sq. on QT (I. 47.)

= Square on diagonal of a square described on QT;

$\therefore$ If a triangle be described with sides equal to PT, TR, and the diagonal of a square described on QT it will be right-angled. (I. 48.) Q.E.D.

7. If a straight line drawn through the centre of a circle bisect a straight line in it which does not pass through the centre, it shall cut it at right angles.

If a straight line be drawn intersecting two concentric circles, prove that the portions of the straight line, intercepted between the two circles, are equal.



Let GHK, LMN be two concentric circles having the common centre O, and let the straight line GK be drawn intersecting them, so that GL and NK are the portions intercepted between the two circles.

Then GL shall be equal to NK.

Proof.—Draw OP perpendicular to GK. (I. 12.)

The straight lines GK, LN are bisected in P (III. 3.)

$\therefore$ PG = PK,

PL = PN,

Wherefore remainder GL = remainder NK. (Ax. 3.) Q.E.D.

8. If two circles touch one another internally, the straight line which joins their centres, being produced, shall pass through the point of contact.

Prove also that if a straight line be drawn through their point of contact, cutting the circumferences, two radii drawn to the points of intersection are parallel.

Let the circle LHM touch the circle GHK internally in the point H.

Let O be the centre of the circle GHK, and P the centre of the circle LHM.

Draw the straight line HLG cutting the circles in L and G.

Join PL, OG.

Then PL, OG shall be parallel.

Proof.—Join OP and produce it to the point of contact H. (III. 11.)

Because OG = OH, (Def. 15.)

$\angle$ OGH = $\angle$ OHG; (I. 5.)

and because PL = PH,

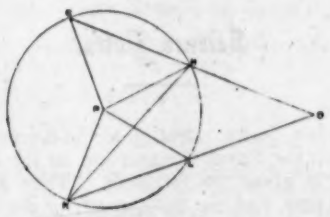
$\angle$ PLH = $\angle$ PHL;

$\therefore \angle$ PLH = $\angle$ OGH, (Ax. 1.)

Wherefore PL, OG are parallel. (I. 18.) Q.E.D.

9. The angle at the centre of a circle is double of the angle at the circumference on the same base, that is, on the same arc.

GH and KL are two chords in a circle which intersect when produced in the point O without the circle. Prove that the difference of the angles subtended at the centre by the arcs GK and HL is double of the angle GOK. (Apply I. 32.)



Find the centre P (III. 1), and join PG, PH, PK, PL, and also HK.

Proof.—$\angle$ GPK = twice $\angle$ GHK
and $\angle$ HPL = twice $\angle$ HKL } (III. 20.)

But $\angle$ GHK = $\angle$s HOK, HKL, (I. 32.)

$\therefore \angle$ GPK = twice $\angle$s HOK, HKL
= twice $\angle$ GOK and $\angle$ HPL,

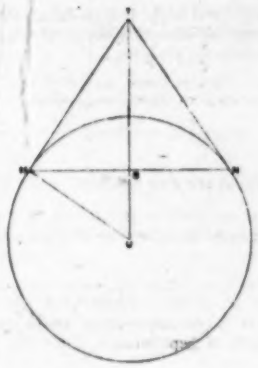
Wherefore difference of $\angle$s GPK, HPL
= twice $\angle$ GOK. (Ax. 3.)

That is, the difference of the angles subtended at the centre by the arcs GK and HL is double of the angle GOK.

Q.E.D.

10. If from any point without a circle there be drawn two straight lines, one of which cuts the circle and the other meets it, and if the rectangle contained by the whole line which cuts the circle, and the part of it without the circle, be equal to the square on the line which meets the circle, the line which meets the circle shall touch it.

From a point T two tangents are drawn to a circle whose centre is U, and TU meets the chord of contact at S. Show that the rectangle contained by US, UT is equal to the square on the radius.



Let MN be the chord of contact.

Proof.—Square on TM = sq. on TS and sq. on SM
" UM = " US " SM } (I. 47.)

∴ Squares on TM, UM = squares on TS, US, and twice square on SM;

But sq. on TU = squares on TM, UM,

and sq. on TU = squares on TS, US, and twice rect. TS. US. (II. 4.)

∴ Rect. TS. US = sq. on SM.

Rect. US. UT = rect. US, ST and sq. on US (II. 3.)
= sq. on SM and sq. on SU
= sq. on UM (I. 47.)
= square on the radius. Q.E.D.

(To be continued.)

—o—

Science Notes.

NATURE has drawn attention to the Science Scholarships which the Royal Commission for the Exhibition of 1851 is about to establish. They amount to £5,000 a-year, and are to be used for the benefit of English provincial colleges, and of colleges in Wales, Scotland, Ireland, and the Colonies. In accordance with the recommendations of a scientific committee, each of the Scholarships will be £150 a year in value, and will be tenable for two years, in rare cases for three; and they are to be restricted to those branches of science (such as Physics, Mechanics, and Chemistry), the extension of which are specially important for our national industries. A series of seventeen scholarships will be allotted to various institutions annually. The first allotment, as the Commissioners explain in a paper they have issued, is to be considered experimental and temporary. The selection now made of institutions to which nominations are offered will be subject to modifications in the future, having regard not only to the manner in which the nominations are exercised, but also to the claims of other universities and colleges which may from time to time be brought under the consideration of the Commissioners

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THE subject of Manual Training has for some time past received a good deal of attention in America. Dr. Fitch, however, tells us in his very valuable and suggestive notes on American Schools and Training Colleges that drawing is the one form of manual training on the value of which all the best educational authorities there are agreed. As to the value of other kinds of Hand-arbeit there are many misgivings. Very costly experiments have here and there been made. Baltimore claims to be the pioneer in the movement. From an American journal it appears that a school was opened in 1884 with 60 pupils and four instructors, now it has 549 pupils and 15 instructors. Manual training has been the chief object, and the ordinary literary work of an advanced school treated as a department. It has not been the intention to teach trades, but the use of tools, and the rudiments of mechanical industry. The regular course of the school takes three years. All the students have their daily work in the shops, drawing rooms, physical laboratory, and literary department. Each class has its own recitation room (*i.e.*, room for oral instruction or catechetical exercise), and only leaves it for drawing and the use of industrial tools. Only 24 boys are in the shop together, but twice that number are taught drawing together. In the first year 15 weeks are devoted to carpentry, five to wood-turning, and 20 to forging. In the second year 15 weeks are devoted to pattern-making, five to moulding, 15 to vice work, and five to soldering and brazing. In the shops instruction is given in the care and use of tools, laying off and designing work, and the composition of the material used. Each class makes some special design for graduation. This year a class is engaged on a 10 horse-power dynamo, 13 lathes, and a Gordon printing-press. The boys also do all the plating required, and make all repairs on the machinery in use. To an ordinary observer this looks like teaching perhaps not one trade, but the rudiments of many. It may suit the requirements of the American lads who are attending the course. Their parents are good judges of that. Whether their time could not be better employed in learning ordinary school subjects, with special attention to drawing, is a question upon which educational authorities, not only in America but also in England, will continue to have strong opinions for some time to come.

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THE third summer meeting of the University Extension and other students began at Oxford on Friday, August 1st. Professor Max Müller delivered an address. He defended the method of teaching by means of lectures, and said much that was thoughtful and wise. The lectures, he admitted, were often too long, three quarters of an hour being in his opinion

quite long enough. It would not have struck us that the length of lectures as they are often given was the weak point about them. A few minutes more or less is not of much consequence. The main point is, have the students been able to follow the lecturer from the beginning to the end of his discourse; or if that is too much to expect, as very frequently it is, have they carried away anything valuable? It may truly be said of many lecturers that they never ascertain, at any part of their discourse, whether their hearers understand them, nor do they take the slightest pains to find out their difficulties and remove them, at least until after the lecture is over.

Professor Max Müller also defended the annual gatherings at Oxford against the charge of being mere academical picnics. He showed how well the different classes of lectures had been arranged so as to meet the different classes of students. He pointed to the large and zealous classes attending the lectures, and to the substantial work done by the students who stayed at Oxford for two or three weeks after the public lectures were given. Finally he dwelt on the silent influence which a stay at Oxford must exercise upon every one, and concluded with one of his own beautiful and weighty sayings 'I doubt not that while teachers and hearers are exploring together the ruins of ancient thought and the labyrinth of modern science, they will feel the silent influence of Oxford, and take to heart the lesson which our University has taught to so many generations of Englishmen, Scotchmen, and Irishmen—respect for what is old, and the warmest sympathy for what is new and true.'

***

PROFESSOR Huxley in a recent letter to the *Times* expressed his opinions upon the question of the most suitable training for medical students. He complains that in the present condition of middle class education the youth of 17 too commonly enters the medical school not only devoid of the slightest tincture of scientific knowledge, but what is worse, so completely habituated to learn only from books or oral teaching, that the attempt to learn from things and to get his knowledge at first hand is something new and strange. He would give more attention to English and give up Latin and, of course, Greek. As matters stand, most likely Professor Huxley is quite right. Is it, however, too much to expect that a lad of 17 should have made a fair acquaintance with the elements of physics and chemistry at first hand, learned the use of his mother tongue, and acquired the essentials of French or German and Latin? How long is the middle class education of this country to be a national reproach? The universities are animated with a strong desire to take part in elementary education. Here is a branch of education which has hitherto been largely, in many cases entirely, in their hands; they have not yet settled what is best to be taught or how best to teach it. If the middle and higher class schools of the country were efficiently staffed, inspected, and examined, Professor Huxley would not have long to wait before his reasonable requirements were complied with. Will Parliament ever find time to deal with secondary education?

Pupil Teachers' Preparation Papers.

TEST PAPERS FOR PUPIL TEACHERS WHO ARE TO BE EXAMINED IN APRIL.

Directions.

1. Write on half sheets of foolscap, and on one side only.

2. At the top of each half sheet write your name in full, the full address of your school, and the year the papers of which you are taking.

3. Do not write the questions, but prefix to each answer the number of the question to which it corresponds.

4. Do not use any book or writing from which answers may be copied.

5. Keep strictly to the time allowed.

6. If you have not time to answer all the questions, choose those you can answer best; but do not omit the whole of any one subject.

7. If you wish them examined, corrected, and valued, send them to the office of the 'PRACTICAL TEACHER,' Pilgrim Street, Ludgate Hill, together with a shilling postal order, not later than the 10th of September. They will be returned post free.

END OF FIRST YEAR.

BOYS ONLY.

Arithmetic.

(*Do three questions only, including No.* 2, *if you can.*)

1. Add together the sum and difference of $1\frac{1}{3}$ and $1\frac{1}{7}$, and divide the result by their product. Express the quotient as a decimal.

2. Explain how you would test, without actual division, whether a vulgar fraction can be expressed as a terminating or recurring decimal.

3. A man who had travelled 365 miles by train, and $\frac{3}{5}$ as far by steamer, completed his journey by a walk equal to $\frac{1}{20}$ of the distance he had already travelled. What was the total length of his journey?

4. From ·4375 of a crown take ·375 of a florin.

GIRLS ONLY.

(*Do three questions only, including Question* 4, *if you can.*)

1. Find by practice the value of a field measuring 3 acres 3 rds. 25 poles at £156 16s. 8d. per acre.

2. Make a bill for the following:—

14 lbs. of bacon, at 7½d. per lb.
25½ lbs. of cheese at 6½d. per lb.
10½ lbs. of butter at 1s. 5d. per lb.
126 eggs at 11½d. per dozen.
5 stones of flour at 1½d. a lb.

3. Find what fraction is equal to $\frac{1}{2\frac{1}{3}} + \frac{3}{4\frac{1}{2}} - \frac{1}{8}$.

4. Show how the method of decomposing two or more numbers into their prime factors will enable us to ascertain both the least common multiple and the greatest common measure of the numbers. Illustrate your answer by the numbers 275, 363, and 660.

Penmanship.

(*For all years.*)

Write in large hand the word *Retrogression*, and in small hand,

To-morrow to fresh fields and pastures new.

Grammar.

BOYS AND GIRLS.

(*Answer Questions* 1 *and* 2, *and one other question.*)

1. The *sun's rim dips*, the stars rush out;
At one stride *comes* the *dark*;
With *far-heard* whisper, o'er the sea,
Off shot the *spectre bark*.

Parse the words printed in italic.

2. Analyse each of the simple sentences in the above stanza.

3. Form nouns by adding affixes to the following words:—
Game, Nurse, Alter, Grow, Neat.

4. What terminations are used to form diminutives? Give examples of each.

5. How do you determine to what part of speech a word belongs? Give some examples of words spelt alike used as three different parts of speech.

Composition.

Read the following passage slowly and carefully once, and then write it from memory.

A Canadian who has spent some time in Hudson's Strait tells of a remarkable method of catching seals. He says 'The Eskimo might be seen lying at full length at the edge of an ice-floe, and although no seals could be seen, they persistently whistled in a low note similar to that used in calling tame pigeons, or, if words can express my meaning, like a plaintive *phe-ew, few-few*, the first note being prolonged at least three seconds. If there were any seals within hearing distance, they were invariably attracted to the spot, and it was amusing to see them lifting themselves as high as possible out of the water, and slowly shaking their heads, as though highly delighted with the music. Here they would remain for some time, until one, perhaps, more venturesome than the rest, would come within striking distance of the Eskimo, who, starting to his feet with gun or harpoon, would often change the seal's tune of joy to one of sorrow, the others making off as fast as possible. The whistling had to be continuous, and was more effective if performed by another Eskimo a short distance back from the one lying motionless on the edge of the ice.'

Geography.

BOYS AND GIRLS.

(*Answer three questions only, including* 1 *or* 5.)

1. Draw a map of (*a*) The English Coast south of the Thames and Severn, or (*b*) Wales, or (*c*) Ireland.

2. Describe the river systems of Lancashire and Yorkshire.

3. Name the most important industries of Scotland, and state in what districts and towns they are carried on.

4. Where and what are the following:—Giant's Causeway, Staffa, Melbourne, Brisbane, Ballarat, the Murray, Ontario.

5. Illustrate the terms used in connection with the physical geography of rivers by reference to the St. Lawrence or the Shannon.

History.

BOYS AND GIRLS.

(*Answer two questions only.*)

1. Which of the Roman generals exercised the most influence over Britain, and how?

2. Describe the course of events which led to the establishment of the Saxons in Britain.

3. What events are connected with the following names:—Boadicea, Augustine, Bede, Dunstan, Guthrum?

4. Sketch briefly the life and character of Edward the Confessor.

5. Give some account of Alfred's struggle with the Danes.

END OF SECOND YEAR.

FIRST PAPER.

(*Three hours and a half allowed.*)

Euclid.

BOYS ONLY.

[All generally understood abbreviations and symbols for words may be used, but not symbols of operation, such as −, +, ×.]

(*Answer two questions, including Question* 3, *if you can do so.*)

1. If two triangles have two sides of the one equal to two sides of the other, each to each, and the angle contained by the two sides of the one equal to the angle contained by the two sides equal to them of the other, then their third sides shall be equal and the remaining angles of the one shall be equal to the remaining angles of the other, each to each, to which the equal sides are opposite.

2. If one side of a triangle be produced, the exterior angle is greater than either of the interior and opposite angles.

3. In any rectilineal four-sided figure, the sum of the four sides is greater than the sum of the two diagonals, but less than twice the sum of the two diagonals.

Arithmetic.

GIRLS ONLY.

(*Do three questions only, including the last, if you can.*)

1. Simplify the following:—

$$\frac{11\frac{1}{4} + 5\frac{1}{4} - 15\frac{1}{2}}{4\frac{1}{21} + 7\frac{13}{91} + \frac{1}{13} - 10}$$

2. What is the value of an estate, if $\frac{3}{25}$ and $\frac{33}{176}$ of it are worth £15,286 16s. 3d.?

3. Reduce $\frac{8}{11}$ of $\frac{3}{11\frac{1}{7}}$ of $5\frac{1}{2}$ to a decimal fraction.

4. State the rule for dividing one fraction by another, and prove it.

Grammar.

BOYS AND GIRLS.

(*Answer Questions* 1 *and* 2, *and one other question.*)

1. Paraphrase the following passage:—

Ethereal minstrel! pilgrim of the sky!
Dost thou despise the earth where cares abound?
Or, while the wings aspire, are heart and eye
Both with thy nest upon the dewy ground?
Thy nest which thou can'st drop into at will,
Those quivering wings composed, that music still!

'*To a Skylark.*'—*Wordsworth.*

2. Analyse the following and parse the words in italic:—

Lightly they'll talk of the spirit that's gone,
And o'er his cold ashes *upbraid him*,
But *little he'll reck*, if they *let* him *sleep* on
In the grave *where* a Briton *has laid* him,

3. Give the meaning of the following prefixes, and show the use of each in three examples:—
Abs, Ad, Pro, Pre, Extra, Contra.

4. Explain the use of the termination in each of the following words:—Doc*tor*, Salv*ation*, Confid*ence*, Radi*ant*, Illus*ory*, Tenac*ious*, Divid*end*, Pen*al*, Expend*iture*.

5. Show clearly the difference between a Transitive and an Intransitive verb, and give instances of Transitive verbs formed from Intransitive verbs.

Geography.

BOYS AND GIRLS.

(*Answer three questions only, including the first, if you can.*)

1. Draw a map of one of the following:—
(*a*) France; *or*
(*b*) Italy; *or*
(*c*) The Spanish Peninsula.

2. Give an account of the natural productions of Turkey and Greece, and of the chief industries of the Turks.

3. Explain as clearly as you can the meaning of parallels of latitude, and meridians of longitude.

4. Describe the course of the Ganges, naming its chief tributaries, and the important towns on its banks.

5. State important facts you know about the following:—The Riviera, Venice, St. Petersburg, Marseilles, Madras, Cashmere, Ceylon.

SECOND PAPER.

(Two hours and a half allowed.)

Needlework.

GIRLS ONLY.

(One hour allowed for this exercise.)

Arithmetic.

BOYS ONLY.

(Answer three questions only, including the last, if you can.)

1. How many men receiving 3s. 7½d. each per day would earn in 37 weeks the same sum that ·51 men receiving 3s. 1d. each per day would earn in 29 weeks?

2. For every pound A possesses B has two guineas, and for every pound B has, C has two guineas. The total amount they possess is £13,142 10s. What is the share of each?

3. A person has £1,050 invested at 4 per cent., £450 at 6 per cent., and £2,500 at 5 per cent. Find the average rate of interest he receives.

4. Three per cent. Stock was bought at 87½, and sold immediately after receiving the dividend at 86½. How much per cent. was gained or lost on the amount invested?

History.

BOYS AND GIRLS.

(Answer three of these questions.)

1. How did the character and action of King John influence the history of the English people?

2. Compare the relations between England and France in the reigns of Henry II. and Henry VI.

3. Give an account of the following persons:—Stephen Langton, Simon De Montfort, John Baliol, and William Wallace.

4. Mention the chief events in the reigns of Edward I., Edward II., and Edward III., with dates.

5. State as clearly as you can the grounds of the dispute which led to the Wars of the Roses. Name the chief battles in these wars, and show how they affected our country's history.

Teaching.

(Answer two questions.)

1. Describe the different steps you would take in teaching a reading lesson in Standard I.

2. What plans would you adopt to prevent children in the lower standards from working arithmetical exercises in such mechanical ways as counting their fingers?

3. Mention any faults you have found to prevail among children of Standard I. in forming and joining letters in writing. How would you endeavour to remedy these faults?

END OF THIRD YEAR.

FIRST PAPER.

(Three hours allowed.)

Euclid.

BOYS ONLY.

[All generally understood abbreviations and symbols for *words* may be used, but not symbols of *operation*, such as −, +, ×.]

(Answer two questions, including Question 3, if you can do so.)

1. The exterior angle of every triangle is equal to the two interior opposite angles, and the three interior angles of every triangle are together equal to two right angles.

2. Describe a parallelogram that shall be equal to a given triangle, and have one of its angles equal to a given rectilineal angle.

3. Let ABCD be a parallelogram and E any point in its diagonal AC. Draw the lines BE and DE. Prove that the triangle ABE is equal to the triangle ADE.

Algebra.

BOYS ONLY.

(Answer three questions only, including Questions 4, if you can do so).

1. Find the continued product of $x + y$, $x + 2y$, and $x + 3y$.

2. Find the G.C.M. of $x^4 - x^3 - 2x + 2$, and $2x^3 - x - 1$.

3. Simplify $\frac{x+y}{y} - \frac{2x}{x+y} + \frac{x^2y - x^3}{y(x^2 - y^2)}$.

4. State the principles on which the process of solving a simple equation is based, and apply them to the solution of the equations,—

(*a*) $\frac{1}{2}(5x - 1) - 6(22 - 3x) = 2x - 3$.

(*b*) $\frac{2x^3 - 3x - 1}{x^3 - 2x + 2} = \frac{2x - 3}{x - 2}$.

Mensuration.

BOYS ONLY.

(Answer one question).

1. A cistern without a lid, whose floor and walls are 1½ inches thick, is 5 ft. 3 in. long, 3 ft. 7 in. wide, and 2 ft. 5½ in. high, measured externally. Find the area of its inside surface, and the cost of painting the inside at the rate of 6d. per sq. foot.

2. A rectangular plot of ground measuring 30 yards by 20 yards, was divided into four equal rectangular beds by two paths of a uniform width of 4 ft., and crossing the centre of the plot at right angles. Another plot of the same dimensions is divided into four triangular beds by two paths along the diagonals, also 4 feet wide. Compare the space occupied by the beds in the two plots.

Arithmetic.

GIRLS ONLY.

(Answer three questions only, including the last, if you can.)

1. An estate measuring 1,595 acres is divided into three farms. The first is $\frac{6}{11}$ of the estate, the second ·375 of the remainder. Find the size of the third farm.

2. If £2 0s. 10d. be divided between eight men and nine boys, each man receiving as much as five boys, what will each boy receive?

3. Find the value of ·21985 of £50 + ·96510416 of £4.

4. A bankrupt is able to pay 6s. 3½d. in the pound. What will be lost by a creditor to whom £563 10s. is due? Explain the question and your method of solving it.

English Grammar and Composition.

BOYS AND GIRLS.

(Answer questions 1 and 2, and one other question.)

1. Paraphrase this passage, and explain its meaning:

> Nature never did betray
> The heart that loved her; 'tis her *privilege*,
> Through all the years of this our life, *to lead*
> From joy to joy: for [she can *so inform*
> The mind that is within us, so impress
> With quietness and beauty, and so feed
> With lofty thoughts, that *neither evil tongues*,
> Rash judgments, nor the sneers of selfish men,
> Nor greetings *where* no kindness is, nor *all*
> The dreary intercourse of daily life,
> *Shall e'er prevail* against us, or disturb
> Our cheerful faith that all which we behold
> Is *full* of blessings.]

2. Analyse that part of the above extract which is enclosed in brackets, and parse the words printed in italic.

3. Select from the passage in question 1 the words which you know to be of Latin origin, and give their derivation where you can. What classes of words are mostly of Saxon origin?

4. Explain the use of prefixes and affixes, and illustrate your answer by examples of Latin and English prefixes and affixes.

5. Make sentences to show how each of the words *but*, *before*, *only*, and *that* may be used as different parts of speech.

Geography.

BOYS AND GIRLS.

(*Answer three questions only.*)

1. Draw a map of
   (*a*) Africa south of the Equator; *or*
   (*b*) India; *or*
   (*c*) The southern shore of the Mediterranean Sea, showing the countries which it borders.

2. Where are the following places, and for what are they noted: Pietermaritzburg, Sierra Leone, Zanzibar, Smyrna, Mecca, Kurrachee, Singapore, Khartoum, Rangoon, Baalbec, Osaka, Fez, and Tabriz.

3. Describe the lake and river system of Eastern Africa.

4. Give some account of the fauna and flora of India.

5. Describe one of the most important currents of the ocean, and state how it is probably produced.

SECOND PAPER.

(*Two hours and a half allowed.*)

Needlework.

GIRLS ONLY.

(*One hour allowed.*)

Arithmetic.

BOYS ONLY.

(*Answer three questions only, including Question No. 4, if you can.*)

1. What is the rate per cent. at which £726 5s. will amount to £743 3s. 11d. in seven months?

2. What difference will be made to a man's income if he first invests £2,500 in the Three per Cents. at 88, then sells out when the price of the stock is 92, and re-invests the amount received in railway shares at 150, and paying 6 per cent.?

3. Extract the square root of 8·678916.

4. A bankrupt pays a composition of 7s. 6d. in the pound. The legal costs of making the arrangement amount to £55 14s. 4½d., equal to 6½ per cent. on the total debts. Find the amount of his assets and liabilities. Explain the terms of the question and the method by which you work it.

History.

BOYS AND GIRLS.

(*Answer three questions only.*)

1. State what causes led to, and what social changes resulted from, the Dissolution of the Monasteries.

2. Mention the most famous men who flourished in the reign of Elizabeth, and briefly sketch the life of one of them.

3. Give an account of the Civil War in the time of Charles I., explaining how it began, mentioning the important battles with their results, and showing how it ended.

4. What were the Pilgrimage of Grace, the Petition of Right, and the Clarendon Code? Give full details of one of these.

Teaching.

BOYS AND GIRLS.

(*Answer two questions only.*)

1. Describe the method you would adopt in correcting a dictation exercise, keeping in view the economy of time and the educational advantage of the children.

2. What plans would you adopt to make mental arithmetic most effectively useful, both for itself and as an aid to written arithmetic?

3. Write notes of a lesson on
   (*a*) Paper making.
   or (*b*) The formation of rivers.
   or (*c*) The classification of adjectives.
   or (*d*) *For Infants.* Right angles.

NOTE.—According to the New Code, pupil teachers at the end of their fourth year will have no examination with the other pupil teachers, but will be required to pass the admission examination either during their fourth year, or in the July following. We do not, therefore, think it necessary to give preparation test papers for an examination which is practically abolished. The change, however, will render it all the more important for pupil teachers in their last year to secure time for the revision of the work of previous years as well as for the study of subjects allotted to the fourth year.

—o—

How my School was Examined.

BY THE HEAD MASTER OF A WEST OF ENGLAND SCHOOL.

STANDARD I.

Arithmetic.—Three sums were dictated:—

1. Add together 692, 54, 7, 63, and 135.
2. From 701 take 107.
3. Take 123 from 512.

Answers.—(1) 951. (2) 594. (3) 389.

Writing.—The following passage was set for transcription on slates from the First Standard reading books. 'Old Mother Goose had lived so long in the world that she had grown wise.'

The following ten words were dictated:—*Mouse, School, Window, Glass, Water, Street, Paper, Clock, Sugar, Church.*

Mental Arithmetic.—How many pence in a shilling? How may halfpennies in 7½d.? If you pay 7½d. out of a shilling what change should you have? And easy questions on the tables up to 6 times 12.

English.—The piece of poetry recited was '*Good Night and Good Morning.*' *(Lord Houghton.)*

Geography.—Who has seen a map? What is a map? Of what country have you seen a map? Who has seen a compass? What is the use of it? Which way does the needle point? What makes it turn to the north? Which is the north side of the school? How can you find the north by the sun.

STANDARD II.

Arithmetic.—Three sets of sums were given:—

A. 1. Divide 58,796 by 9.
2. Multiply 7,985 by 608.
3. Multiply 59,374 by 49.
4. From 80,030 take 70,936.

B. 1. Divide 58,796 by 12.
2. Multiply 7,985 by 760.
3. Multiply 59,374 by 57.
4. From 80,030 take 608.

C. 1. Multiply 6,294 by 47.
2. Multiply 8,673 by 96.
3. From 21,021 take 19,019.
4. Divide 64,879 by 9.

Answers: *A.* (1) 6,532 + 8 over. (2) 4,854,880. (3) 2,909,326. (4) 9,094.

B. (1) 4,899 + 8 over. (2) 6,068,600. (3) 3,384,318. (4) 79,422.

C. (1) 295,818. (2) 832,608. (3) 2,002. (4) 7,208 + 7 over.

Writing: Two pieces of dictation were given, the one from Stories of Animals, page 83, the other from Longmans' Second Standard Reader, page 85.

A.—I must tell you now how the mother bear spends the winter. She lies down in some ice-cave, or she scratches a hole in the snow and gets into it. There she sleeps till spring time. When she comes out of her hole, she is very thin and very hungry.

B.—All mice make very nice warm nests for their young ones, out of such things as paper, hair, moss, or feathers. But the harvest mouse makes a very pretty nest of bits of grass, which it hangs on the stalks of wheat or grass, about a foot from the ground.

English.—The piece recited was '*Casabianca*,' by Mrs. Hemans. Questions were asked on the meaning of words, such as *deck, whence, wreck, heroic, unconscious, booming, banners, fragments, pennon, helm.* Why did the boy not leave his post? Why did the father not answer him? What lesson is to be learnt from this poem?

Sentences were given containing certain words used as different parts of speech, and the children were asked to tell whether they were nouns or verbs. The *swallow* flew away. Can you *swallow* that? Look at that *fly*. It cannot *fly*.

Geography.—The teacher was allowed to ask questions on the definitions, and the inspector supplemented them with a few others. What is a gulf? a peninsula? a cape? Why is a cape so called? What other names are used for capes? What does *ness* mean? Point to a cape on the map of England. What is it called?

Singing.—Standard I. and II. were examined together. An easy voluntary was pointed on the modulator. Phrases were sung by the inspector, and the children had to imitate them, such as **s f m**; **m r d**; **s l t d'**; **s d' t d'**. The following songs had been prepared.

'Who hath no Sunshine in his Heart.'
'How happy is the Woodman's lot.'
'Come, let us gaily wander.'
'Gentle Spring.'
'We need not look always,'
The inspector chose the fourth of these to be sung.

STANDARD III.

Arithmetic.—Specimen Cards.

A. (1) Take £194 11s. 5¾d. from £43,082 10s. 2¼d.
(2) Multiply 97,082 by 608.
(3) Add £21,720 12s. 0¼d., £982 17s. 10¾d., £1,307 12s. 9¾d., £89,073 9s. 8¼d., and £73,000 9s. 0¼d.
(4) 25 screws were used in the making of each of 42 boxes; the screws were bought at the rate of ten for a penny. How many pence did they cost?

B. (1) Add £705 15s. 8½d., £69 16s. 7d., £77,895 12s. 11¾d., £19 9s. 9¾d., and £6,037 7s. 6½d.
(2) Multiply 43,759 by 906.
(3) How much must be added to £3,909 18s. 7¾d. to make £60,060 17s. 4½d.?
(4) Two boys and a girl save £10 between them. Each boy saves £2 15s. 6d. How much does the girl save?

Answers.—*A.* (1) £42,887 18s. 8½d. (2) 59,025,856. (3) £186,085 1s. 5¾d. (4) 105 pence.

B. (1) £84,728 2s. 7½d. (2) 39,645,654. (3) £56,150 18s. 8¾d. (4) £4 9s.

Writing.—The following passage was dictated from Longman's New Reader for Standard III., p. 87:—

'Rob went back eager and joyous. Forthwith a thorough inspection of the boat was set about by the lads. They tested the oars, they tested the tholepins, and they had a new piece of cork put into the bottom. For that evening, when it grew a little more toward dusk, they would make their first cast with the net.'

English.—The piece for recitation was 'Try Again,' the story of Bruce and the Spider by Eliza Cook. Questions were asked on the teaching of the poem, and on the meaning of the words and phrases, such as *lonely mood, monarch, divine, defied despair, braced his mind, silken cobweb clue.* Words were selected from the reading books for the children to tell the parts of speech.

Geography.—Questions were asked on the cloth manufacture and the towns engaged in it, including those in Wiltshire and Somersetshire. Many details asked respecting the manufactures, and occupations of the people on the Northern coal-field; also on the places where fish-curing is carried on.

Singing.—The following list of songs was presented, and the first and fourth were selected to be sung:—

'Come now let us jovial be.'

'Hope will banish Sorrow.'

'Cheerfully the sailor sings.'

'Once again is stilly Night.' (*Naumann.*)

'The Merry Spring returneth.' (*Hering.*)

A few ear tests were given such as m r d; l t d'; s l t; f m r.

STANDARD IV.

Arithmetic.—Specimen Cards:—

A. 1. Multiply £987 13s. 11½d. by 506.

2. Divide £20,763 13s. 7½d. by 87.

3. Reduce 17,906 stones to tons.

4. Two men started on a walking match for five miles. The winner gained 8 feet on every 110 yards. How much was he before the other at the end of the race?

B. 1. Divide £58,388 7s. 9½d. by 74.

2. Multiply £946 12s. 3½d. by 132.

3. Reduce 71 cwts. to ounces.

4. If a picture cost 2s. 11½d., how many such pictures could I buy for £7 2s.?

Answers.—*A.* (1) £499,774 12s. 4½d.; (2) £23 16s. 8½d.; (3) 111 tons 18 cwt. 1 qr.; (4) 38 pls. 4 yds. 1 ft. or 640 ft.

B. (1) £789 os. 7½d.; (2) £124,933 2s. 6d. (3) 127,232 ounces; (4) 48 pictures.

Writing.—The following passage was dictated from Nelson's Royal Reader, No. 4, page 81:—

'On one occasion a poor drummer, crawling out from the mass of snow which had torn him from his comrades, began to beat his drum for relief. The muffled sound came up from his gloomy prison, and was heard by his brother soldiers, but none could go to his rescue. For an hour he beat rapidly, then the strokes grew fainter and fainter, until they were heard no more, and the poor drummer laid himself down to die.'

English.—The piece recited was the Introduction to 'The Lay of the Last Minstrel' by Sir Walter Scot. Questions were asked on the meaning of words and phrases, on the parsing of the line 'He tried to tune his harp in vain,' and on the kinds of pronouns.

Geography.—The teacher was allowed to ask questions on the rivers and mountains of Scotland.

The inspector asked questions on the geography of British North America. What island near North America belongs to England? What has lately caused it to be much talked of? What fish is caught on the coast of Newfoundland? What river opens into the sea near this island? For what is the St. Lawrence remarkable? What is the character of Canada? What occupations are the people engaged in? What country is on the south side of the St. Lawrence? What forms the boundary between Canada and the United States in the Western part? What parallel of latitude? What do we mean by a parallel of latitude? Name the chief towns in Canada, etc.

Singing.—The following time test was given:—

| 1 : 1 | 1 : 1 | 1 :– | 1 :– | 1 : | 1 : | 1 :– | – :– |

A voluntary was pointed on the modulator. The following two-part songs had been prepared, and the inspector chose the last two to be sung:—'Home, Sweet Home,' 'The Hardy Norseman,' 'The Pilot' (*Nelson*), 'Out in the Frosty Morning Air,' 'Sing ye Poets' (*Lachner*).

STANDARD V.

Arithmetic.—Specimen cards:—

A. 1. Find, by practice, the value of 2 acres 3 roods 16 poles at £15 3s. 4d. per acre.

2. How much coffee can be bought for £15 if 8 lbs. 6 ozs. cost 11s. 2d.?

3. Make a bill for 10 coats at £3 5s. each; 18 yds. of lining at 7d. per yd.; 19 yds. at 1s. 3d. per yd.; 14 at 1s. 9d. each; 2 pieces of cloth, each 17½ yds., at 2s. 4d. per yd.

4. There are two bags of flour, one containing 1½ cwts, the other 67 lbs., what is the difference in their value if the flour is worth 2d. a lb.

B. 1. Find the sum gained by selling for £9 10s. 9d. each, 1050 articles which cost £8 3s. 7¼d. each.

2. Make out a bill for 37 shrubs at 3s. 9d. each, 47 geraniums at 8¾d. each, 25 fuchsias at 6½d. each, 17 roses at 3s. 7d. each, digging half a acre at £7 10s. per rood.

3. Find the value of $\frac{5}{7} + \frac{2}{9} - \frac{3}{8} + \frac{5}{8}$.

4. A railway 23 miles in length cost £22,448 to construct. What would it cost to make it 7 miles longer.

Answers.—*A.* (1) £43 4s. 6d.; (2) 225 lbs. (3) £62 10s. + 10s. 6d. + £1 3s. 9d. + £1 4s. 6d. + £4 1s. 8d. = £69 10s. 5d. (4) 16s. 10d.

B. (1) £1,427 6s. 10½d. (2) £6 18s. 9d. + £1 14s. 3½d. + 13s. 6½d. + £3 os. 11d. + £15 = £27 6s. 11¾d. (3) $1\frac{37}{504}$. (3) £6,832 more, or £29,280 in all.

Writing.—The following story, from the 'Composer and Essayist,' page 72, was read over twice, and the boys had to write it from memory:—

'Charles the Fifth, Emperor of Germany, was once walking along the road near Vienna, when he fell in with a peasant who was carrying a pig on his back. The pig screamed very lustily, which annoyed the emperor very much. Finding the noise became intolerable Charles stopped the man, and asked, "don't you know any plan of making the pig be silent?" He acknowledged at once that he did not, so the emperor said, "take the pig by the tail, and you will find it quiet." The peasant tried this plan, and found it to answer very well. Quite pleased with the success of the trick, he exclaimed, "You must have been at the trade much longer than I have, sir, for you understand it better.'

STANDARD VI.

Arithmetic.—Specimen card :—

1. Find the difference between ·00078125 of a ton and $\dot{6}$ of $2\frac{1}{4}$ lbs.

2. Simplify—

$$\frac{\frac{2}{3}\text{ of }2\frac{3}{5}}{\frac{5}{6}+\frac{7}{10}} - \frac{2\frac{1}{4}-1\frac{3}{10}}{\frac{3}{8}\text{ of }1\frac{2}{7}}$$

3. If 17·25 lbs. of tea cost 43·125 shillings, how much tea can be bought for £5 14s. $4\frac{1}{2}$d.?

4. What is the smallest sum of money we can add to £47 19s. $3\frac{1}{4}$d. in order that the total may contain 17s. $3\frac{3}{4}$d. an exact number of times?

Answers.—(1) $\frac{1}{4}$ lb. or ·25 lb. (2) $\frac{40}{163}$. (3) $45\frac{3}{4}$ lbs. (4) 10s. $2\frac{3}{4}$d.

Writing.—The following subjects were given for Composition.

A. African Explorers.

B. A Holiday in China.

C. A Visit to a Museum in London.

STANDARDS V. AND VI.

English.—The poetry for recitation was the quarrel between Brutus and Cassius in Shakespeare's play of Julius Cæsar. Two boys at opposite ends of the class were set to take the two characters. After a time two others had to take it up. Then others were tested individually by being asked for the rejoinder to certain speeches. A few questions were asked on the meaning, and the sentence, 'You say you are a better soldier,' was fully parsed and analysed.

Geography.—The geography prepared was that of Asia, Africa and America, with maps of India, Africa, and South America. The maps were given to be drawn from memory, and searching questions were asked, especially on North America and China. What is the capital of the United States? What is the largest town? What is its population? The largest city in the world? Is New York greater or less than London? What is the St. Lawrence noted for? What are the chief productions of Canada? How are the people employed? What is lumbering? What animal productions are obtained? What mineral productions? What rivers run northward through the Dominion of Canada? What is Manitoba? What is it remarkable for?

Name the most populous country of Asia? What do we obtain from China? Where is tea grown largely now? What articles of common use take their name from the country? Name an important animal production obtained from China? What are the people very clever in? How do they differ in appearance from English people? How do they dress? Name some of their towns. Where is Japan? What is remarkable about the present condition of Japan? How then do they differ from the Chinese?

Singing.—The following list of songs, mostly in three parts, was presented, and the first was chosen by the inspector as a test:—

'Here by Friendship firm united' (*Mozart*).
'Awake, and Rub your Clouded Eyes' (*Widmann*).
'Softly Rustle the Leaves' (*Carl Seitz*).
'The Postillion' (*Mendelssohn*).
'The Charm of Life' (*Kunkel*).

Some questions were asked on time, one boy having to write a measure of four pulses, which the rest were required to sing to *lah*.

Algebra.

STAGE I.

1. Divide $8x^4y + 2x^3y - 2x^2 - 3x^2y + x$ by $2x^2 - x$.

2. Multiply $1 + 2x + 3x^2 + 4x^3 + 5x^4$ by $1 - 2x - x^2$.

3. Add $2x - 3by$, $ax + 4y$, $3x + by$, $y - 2ax$.

4. Subtract the sum of $3a - 2b$ and $2b + 3c$ from $5a - b + 2c$.

5. A school contains x classes; in each class are y boys. How many boys are in the school?

STAGE II.

1. Find the L. C. M. of $7(a^2 - x^2)$, $9(a + x)^2$, $15(a - x)$, $3(a^2 + x^2)$, $21(a^4 - x^4)$.

2. Reduce to its lowest terms $\frac{36x^4 - 13x^2 + 1}{30x^3 - 19x^2 + 1}$.

3. Simplify $\frac{1}{5(2x-1)} - \frac{1}{3(2x+1)} + \frac{1}{15(x-2)}$.

4. Solve—(*a*) $6x - 2(9 - 4x) + 3(5x - 7) = 10x - (4 + 16x) + 25$.

(*b*) $\frac{x-7}{x+7} = \frac{2x-15}{2x-6} - \frac{1}{2x+14}$.

5. A and B can do a piece of work in 4 hours, A and C in $3\frac{3}{5}$ hours, and B and C in $5\frac{1}{7}$ hours; in what time could they do it separately?

Answers.—*I.* (1) $4x^2y + 3xy - 1$. (2) $1 - 6x^5 + 5x^6$. (3) $5x - ax + 5y - 2by$. (4) $2a - b - c$. (5) xy.

II. (1) $315(a + x)(a^4 - x^4)$. (2) $\frac{6x^2 + 5x + 1}{5x + 1}$.

(3) $\frac{16x - 17}{15(4x^2 - 1)(x - 2)}$. (4) (*a*) 2, (*b*) 8.

(5) 6 hours, 12 hours, 9 hours.

List of Examiners in the University of London for the year 1890–91.

Latin.—J. S. Reid, M.A., and Professor R. Y. Tyrrell.

Greek.—G. E. Marindin, Esq., M.A., and Rev. H. Holden, M.A.

English.—Professor E. Arber, F.S.A., and Professor John W. Hales.

French.—Amédée Eschlangon and Henri Bué, Esq.

German.—Professor C. A. Buchheim and F. Althaus, Ph.D.

Mental and Moral Science.—Professor R. Adamson and Professor W. Knight,

Political Economy.—Professor C. F. Bastable, M.A. and Professor J. S. Nicholson, D.Sc.

Experimental Philosophy.—O. I. Lodge, D.Sc., F.R.S., and Professor R. T. Glazebrook, Esq., M.A.

Chemistry.—Professor H. G. Armstrong, Esq., F.R.S., and Professor W. A. Tilden, Esq., F.R.S.

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Geology.—Professor W. Boyd Dawkins, Esq., F.R.S., and Professor Charles Lapworth, F.R.S.

Music.—W. Poole, Esq., Mus. Doc., F.R.S., and Sir John Stainer, Mus. Doc., M.A.

Publications Received.

BACON & CO.—Excelsior Test Map of Western Europe.

BELL, G., & SONS.—Elementary Arithmetic (*Pendlebury & Beard*); Elements of Euclid, Book I. (*Deighton*).

CARY, ALPHONSE.—Musical Intervals at Sight (*Rendel*).

CLIVE, W. R., and Co.—London Inter. Arts Directory (July, 1890); London Inter. Science Directory (July, 1890); A History of the Reigns of Augustus and Tiberius (*Allcroft and Haydon*); Tacitus, Annals I. (*Mason and Fearnside*); Heat and Light Problems (*Wallace Stewart*).

CURWEN & SONS.—Up with the flag! (Action Song by *Cowley*); The Merry Drummers (Action Song by *Jackman*); Castles in the Sand (Action song by *Jackman*); School Cantata: Happy Hearts, or May's Birthday Party (*Murdoch*).

DAWSON, A. G.—A Children's Play: The Magic Lamp (*Richmond*); The Townley Algebraical Tests, Part 3 (*Ellery*).

FISHER UNWIN, T.—The Century Magazine. September.

LONGMANS & CO.—Longmans' Junior School Atlas; Longmans' School Atlas; Longmans' French Course, Part I. (*Bertenshaw*); Longmans' New Atlas; Inorganic Chemistry (*Jago*).

MISCELLANEOUS.—The Third Annual Report of the National Association for the promotion of Technical and Secondary Education (1889-90); The East London Magazine. August.

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University Correspondence College Tutorial Series, Heat and Light. By R. W. Stewart, B.Sc. Cambridge: W. B. Clive and Co.

This is a well printed and well illustrated book of more than 300 pages. It is primarily intended as a text for those who are preparing for the matriculation examination of the London University; but while it includes all that is comprised in that course it is also very well fitted for general use. It strikes us as a trustworthy guide, and we hope it may have a wide circulation.

The First Latin Primer. By J. P. Postgate, M.A., Litt. D. London: Cassell and Co.

Professor Postgate has done in this manual a piece of work for which he deserves the thanks of schoolmasters and pupils alike. Perhaps the most valuable amongst the many merits of this Primer is the exceeding care which the author has expended in the choice of the necessary and rejection of the unnecessary, or less primarily important grammatical facts. By this selection he has been able to set down on a few over one hundred pages a pretty complete statement of the essentials of Latin Accidence and Syntax, and the gain to the learner is twofold. His attention is not distracted from the main points by the accumulation of comparatively rare and insignificant deviations from the normal usage of the language; and in the second place, he is not disheartened nor fatigued from the very outset by a needless display of the length of the journey he is beginning, and the difficulties which lie in the road. The treatment of the third declension is a very good instance of successful simplification of the Accidence; the dissertation on the complex sentence is another example from the Syntax; that bugbear of schoolboys in middle forms, the conditional sentence, loses its terrors, so terse and simple are the rules laid down for its correct expression.

All through the book the aid of the various devices of the typographer are utilised for emphasis and classification. There is no one who as learner, or *a fortiori* as teacher, has wandered in the dreary wastes of the old Latin Grammars, with their large type and small, their page-long lists of 'exceptions,' their appendices and excursus, but will echo the welcome we give to this truly reasonable and judicious text-book.

The Elements of Euclid, Book I. Horace Deighton, M.A. London: Deighton, Bell and Co.

This is a revised reprint from the editor's larger work it is issued with the object of supplying the wants of those students whose requirements are smaller and who naturally look for a smaller book. The arrangement of the steps in the propositions is exceedingly clear and easy to follow. The printing is also a model of neatness and effectiveness. The main feature of the book is the number and character of the exercises. These are unusually numerous. Many of them are easy enough to tempt a beginner to try his uttermost to conquer the difficulty before him. The author is of opinion that to answer such questions as are continually being set the pupil needs to know more geometry than is taught in Euclid's Elements, especially on the subjects treated of in the first book. He has therefore enunciated some 38 propositions which the student should make himself thoroughly familiar with. This strikes us as a most useful feature. There is a most conservative, in many quarters almost a reactionary, spirit in regard to any deviations from the traditional text of Euclid. We doubt if logic gains while we are sure that geometry loses by this rigid and slavish deference to the work of a great teacher. The 48 propositions of Euclid's first book do not deal fully or even adequately with the subjects treated, and we have in the volume before us 38 others many of them of as great interest and import as any in the classical 48.

We have formed a high opinion of Mr. Deighton's book, and have no hesitation in recommending it.

University College Correspondence Tutorial Series Matriculation Directory. No. 8. June, 1890. Cambridge: W. B. Clive and Co.

This edition contains the latest requirements for this examination and much other useful information. A list of suitable books for each subject is recommended. The matriculation questions set in June, 1890, are worked out in full by competent men. These cannot but be useful to those who intend passing the examination at an early date. These directories are brought out with the greatest regularity and promptness at a considerable cost, no doubt, of time and labour.

Horace, Odes, Book II. Edited by A. H. Allcroft, B.A., and B. J. Hayes, M A. Univ. Corr. Coll. Series. London: Clive and Co.

This is altogether a well-arranged and useful book. The paper and type are unexceptionable. A little more care in the revision of proofs would have eliminated the rather too frequent misprints. For the sake of a later edition we may point out *fortuito* for *fortuitum* in the note on xv., 17; *sustulerit* for *sustulerat* in that on xvii., 28; *occupari* for *occupavi*, note on xviii., 5; and *trilinqui* for *trilingui*, note on xix., 23. There is also a superfluous full stop in the text of x., 16. The translation of *solutis* by 'glowing' in v., 23, must be counted as an oversight, as well as that of *cornu*, by 'bow' (xix., 30). In the latter case, the note on the passage gives the true meaning. The notes are clearly written and generally accurate; their faults are mostly of omission. We cannot agree with the selection of the editors, in refusing a line or two of explanation for *fortuitum caespitum* (xv., 17), and *quem vocas* (xx., 6). So, too, the bare translation seems insufficient for such expressions as *atterens caudem* (xix., 30); *residunt cruribus asperæ pelles* (xx., 9—10). The student's attention might have been called to the Horatian *sensi* (vii., 8); *metuente solvi* (ii., 7), deserves illustration; so does the use of *propriam* (ii., 22). That the construction of *contremuit* with a direct accusative (xii., 7), should have been left unnoticed is another strange omission. The translator may be congratulated on having done his difficult task not unsuccessfully. He has stuck very closely by his original, yet at the same time avoided the dulness of an entirely prosaic rendering. His renderings are from time to time happy and suggestive; and his version does not want in rhythm and lively expression.

A New Geography on the Comparative Method with maps and diagrams. By Professor Meiklejohn M.A. Third Edition. St. Andrews. A. M. Holden.

No surprise need be felt that this work has reached a third edition. Prepared on sound educational lines, it was bound to secure for itself an important position among the numerous manuals on geography. It is a sign of the times that even a text book has been framed with psychological laws kept well in view. Many, if not most of the text books on geography, are mere collections of facts, where cause and effect are seldom brought into juxtaposition for the benefit of a young reader, and where the imagination is left, like a street arab, to play as it pleases. But Professor Meiklejohn's book not only developes the reasoning faculties, and guides and stimulates the imagination, it aids the memory by comparison and contrast. Much of geography is a matter of memory, and the student is under great obligation to those who so arrange his matter that it becomes easy to incorporate. This assistance to the memory is the most valuable feature of the book. In one or two instances, however, the desire to aid the memory has been pushed a little too far. It cannot help a young student much to be told that Trondhjem, in Norway, is about one-fourth the size of Birkenhead. How many students of Geography know the size of Birkenhead? Again, Riga is stated to be as large as Newcastle, the fifth city in the Russian Empire, and the third seaport in Russia.

The plan of the book is simple, but there is a slight lack of uniformity. Taking England, for instance, and beginning with the rivers, we have next lakes, then minerals, climate, vegetation and animals. In the plan for Scotland we have rivers, lakes, climate, vegetation, and minerals. The heads of the plan are suitable, but we think 'population' and 'populousness' might stand under the old fashioned head of 'population.'

The matter is, on the whole, well distributed. We find, for example, that Mexico has three pages allotted to it, and the United States fourteen. This is a judicious disposition; but we think that the whole of the British North American possessions are worthy of more attention than three-fourths of the space given to Russia in Europe. Besides being well distributed, the matter is exceedingly attractive. Delightful bits of information are scattered liberally throughout the book, as, for instance, on p. 45, where the derivations of Shropshire and Shrewsbury are introduced. The description of London on p. 40 is very graphic; but we do not like the expression that 'London is a forest of human beings.' On p. 21 it is stated that despotic government has disappeared from Europe. Let us hope the inhabitants of Russia and Turkey think so. On p. 167 it is stated that 'the vice of both nations (Norway and Sweden) is intemperance.' This scarcely holds for Norway. Drastic changes have taken place in that country during the last few years, legislation having worked wonders. On p. 34 it is stated that a line from Exmouth to the Wash marks the southern boundary of the mineral districts. This will do as a general statement, but cement is produced South of that line in large quantities; iron was formerly worked in the Weald, and coal has just been found in the Channel Tunnel sinking.

The articles on government and religion are not full enough.

The maps vary much in point of clearness. Those of Africa and Australia are not so striking as that of South America. There should also be better maps of Canada and the United States.

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There are, we think, too many instructions for mapping, fifteen separate directions being furnished for Europe. Lines of latitude and longitude should be furnished.

Scott, Marmion: Edited with Introduction and Notes. By Thomas Bayne. Oxford: At the Clarendon Press.

Through the medium of this excellent edition, we have renewed our acquaintance with Scott's spirited and romantic poem with feelings of lively interest. In a well written introduction, the editor records the circumstances under which the poem was composed, describes its chief characteristics, and cites some of the most important criticisms with which its appearance was greeted. The notes are abundant and include the greater part of those supplied by the Author, who was by no means sparing in his annotations. They have, however, the special merit of throwing real light on the various features of the narrative, and so they increase the student's interest in the poem. Mr. Bayne has made use of Lockhart's works and many others in the elucidation of difficulties. The printers, publishers, and binders, have done their several parts to produce a very attractive volume for book-lovers as well as students.

Lectures on Language and Linguistic Method. S. S. Laurie, A.M. Cambridge University Press.

These lectures on language and linguistic method in the school were delivered last year in the University of Cambridge. They contain much that is thoughtful and true, and a good deal which is not very likely to carry conviction. For instance, did the author really expect a boy to have read even with the aid of a translation the enormous list of books named on page 138. We think not. We strongly recommend the book, especially now, when we are, perhaps, a little in danger of thinking too little of language and too much of things, a natural but fatal mistake. 'My object,' the author says, 'in this brief course of lectures, has been to demonstrate that language must always be the governing subject in all education worthy of the name.' But he distinctly disavows an intention of attacking science teaching, and admits that there ought to be found in every school a graduated and organised 'system of realistic teachin rom the infant school to the gates of the University.'

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These lectures on language and linguistic method in the school were delivered last year in the University of Cambridge. They contain much that is thoughtful and true, and a good deal which is not very likely to carry conviction. For instance, did the author really expect a boy to have read even with the aid of a translation the enormous list of books named on page 138. We think not. We strongly recommend the book, especially now, when we are, perhaps, a little in danger of thinking too little of language and too much of things, a natural but fatal mistake. 'My object,' the author says, 'in this brief course of lectures, has been to demonstrate that language must always be the governing subject in all education worthy of the name.' But he distinctly disavows an intention of attacking science teaching, and admits that there ought to be found in every school a graduated and organised 'system of realistic teachin rom the infant school to the gates of the University.'

Whittaker's Progressive German Course: Advanced German Reader. By Franz Lange, Ph.D., and J. F. Davis, D.Lit. London: Whittaker and Co.

This is a book of 250 pages, containing passages in prose and verse for students sufficiently advanced to read continuous prose and poetry with the aid of a grammar and dictionary. Short but useful notes are supplied as an appendix. The type is both large and clear. The prose passages are printed in German characters, but not the poetry. The reason for this is not obvious; perhaps, however, because the poetry may be considered a little more difficult than the prose. More and more importance is being attached to German, and we have no doubt this volume of extracts will be welcomed in many classes especially where the elementary course has already been in use.

Literature Primers: Questions and Exercises on English Composition. By Professor Nichol, LL.D. and W. S. M'Cormick. London: Macmillan and Co.

This is a useful book, though only to those who are using the Primer on Composition by the same author. In that succinct and suggestive little book Professor Nichol did a good deal to show that much might be done to teach an industrious student what to aim at and what to avoid in the matter of English composition. The collection of questions and exercises before us is intended to make the use of that manual more real and profitable. We have no hesitation in saying that any one who carefully reads the primer and then works these exercises will immensely profit by it. Few efforts are better repaid than those spent upon the study of the mother tongue.

The Civil Service Geography. P. Gray, C.B. London: Crosby Lockwood and Son.

This work has reached a tenth edition. It is therefore in no need of an introduction. The enlarged and corrected edition before us will doubtlessly circulate more largely than before among those for whom it was written. The object which has been aimed at, and we think successfully aimed at, is to present as many facts as possible without any undue prolixity. Advantage has been taken of tabulating where it seemed desirable and every effort has been used to get the greatest amount of information into the smallest space. Care has been taken to select what seem to be the most important facts. Where there was so much to be rejected judgment was needed in making a judicious selection. As the title of the book indicates it is an examination manual. Any one who wanted to study geography for any other purpose than to pass an examination could certainly find a more attractive and stimulating setting of the whole subject.

Blackie's Tot Cards. Compound Addition (Money). London: Blackie and Son.

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